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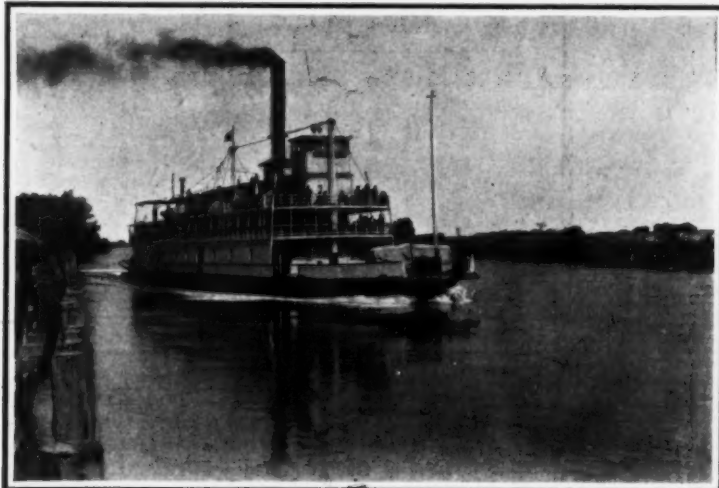
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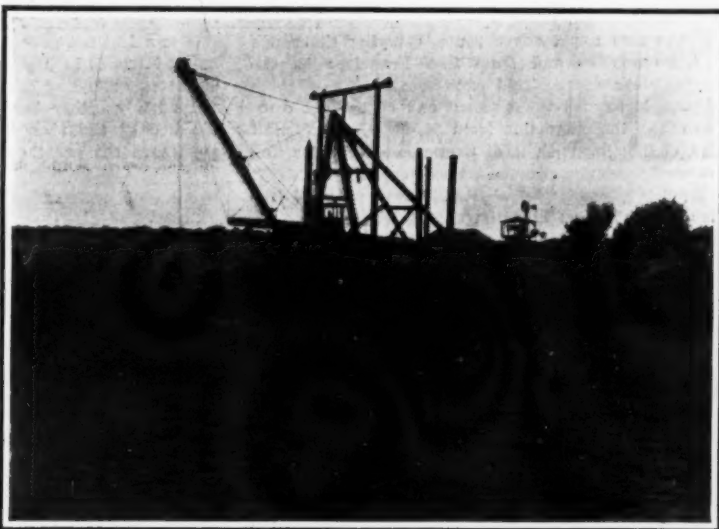
SECTION OF SACRAMENTO RIVER SHOWING LEVEES AND ADJOINING FARM LANDS.



SOUTHERN PACIFIC COMPANY'S STEAMER "NAVAJO" ON THE SACRAMENTO RIVER.



CANNERY ON BANK OF SACRAMENTO RIVER. RIVER TO LEFT—NOT SHOWN.



DREDGER AT WORK ON LEVEE ON SACRAMENTO RIVER.



LEVEES ON BANK OF SACRAMENTO RIVER TO LEFT. LEVEE IN FOREGROUND USED ALSO AS A COUNTRY HIGHWAY WITH FARMS AND ORCHARDS TO RIGHT, THE PROBLEM OF THE SACRAMENTO RIVER.

THE PROBLEM OF THE SACRAMENTO RIVER.

BY H. C. CRAFTS.



JUNCTION OF SACRAMENTO AND SAN JOAQUIN RIVERS AT SUISUN BAY.

THE Sacramento River, California, presents one of the most interesting studies of the day.

In the first place, it is interesting from an historical point of view. In the early days of California there floated down its waters millions in gold, the product of the mines of the New Eldorado, in the flush of their glory.

It was also a passenger route, carrying thousands of Argonauts to and from San Francisco in the feverish days of the gold excitement.

Again, it formed the western end of the old overland route, the stage line from St. Joe, Mo., via Salt Lake, connecting with it at Sacramento City for San Francisco, and it continued in that capacity until the completion of the Central Pacific Railroad and the establishment of an all-rail transcontinental route.

After that it lapsed into the character of a local waterway, and in that capacity has served, and is still serving, as an important artery of local transportation.

Yet it would seem to serve in a somewhat broader capacity. In the early days, ocean-going steamers drawing as much as eighteen feet of water plied as far up as Sacramento, and there took on cargoes destined beyond the Golden Gate.

To-day vast quantities of the products of the farms and orchards lying contiguous to the river, both above and below Sacramento, are gathered by river steamers and other craft, carried to Sacramento, and there transferred to the railroad yards for shipment to the east via the overland routes.

And in spite of its changes in physical features, and the construction of a network of railroads on both sides, it has maintained its importance as a navigable stream and an artery of commerce.

Local steamboat lines have multiplied as the years have passed, and the great Sacramento valley has been developed; and to-day these lines are taking measures to increase their carrying capacity, while other means of transportation have been, and are being, supplied, from the gasoline launch to the big grain barge.

And it is this development of industry, coupled with the surrounding physical conditions, that is making the care and control of the Sacramento River one of the great problems of the day—a problem that assumes even a national importance.

In the first place, the Sacramento valley presents itself as one of the garden spots of the earth!

Prof. Elwood Mead, government irrigation expert, who has made a thorough investigation of the region, asserts that the valley contains not less than thirteen million acres of rich, arable land, with an ample water supply to irrigate the whole of it; that he finds the soil and climatic conditions equal to the valley of the Po or the Nile.

He then advances the opinion that the Sacramento valley, if irrigated and cultivated to its full capacity, would attain a productiveness sufficient to support a population of five millions.

Already the industrial development of this rich valley has been far advanced. To-day it is a well-cultivated tract, producing probably a larger variety of farm, orchard, and garden products than any other like area in the world.

Yet this same Sacramento River in its present stage is a handicap and a constant menace to contiguous

industry, by reason of the weakness of its banks, and the volume of its waters during the spring floods.

Naturally the river lands are the richest and the most productive; and naturally again these are the lands that are endangered and oftentimes devastated. This condition only adds to the gravity of the situation.

It is a fact not generally understood that the Sacramento River is held within its banks only by a system of levees extending for a distance of more than 200 miles along either bank; and it is also a fact that the bed of the river is constantly rising in consequence of the great quantities of silt and fine sand brought down from the watershed of the Sierra Nevada mountains, and carried along its course in semi-suspension, and distributed all the way to its mouth and even into the bays of Suisun and San Pablo.

Slowly the bed of the river has filled, and with even pace the levees on each bank have been built higher, until the banks are more than twenty feet higher than they were originally, and the bed of the river even more than that above its original level; for with all the dredging in the process of levee building, the sands have constantly encroached upon the depth of the water.

In the old days, as I have said, ocean-going steamers, drawing eighteen feet of water, were wont to ply as far up as Sacramento, even at low water; but to-day river steamers, drawing only five feet of water, are almost daily going aground on the sand bars forming at intervals from Sacramento some six or seven miles down stream, while I am told that no craft that draws more than four feet of water can navigate the stream above Sacramento.

The impression at one time became general that much of this sand drift came from the placer diggings on various tributaries of the Sacramento; and in response to a somewhat clamorous demand, the Legislature passed very stringent laws against the running of placer washings into the Sacramento or any of its tributaries.

But the contention that the filling of the river was largely in consequence of mining operations does not appear to have been well founded, for the sand drift in the Sacramento is as bad as ever.

The true solution of the question appears to be the theory advanced to me recently by an old river captain. He attributes the increased sand deposits to the destruction of the forests on the slopes of the Sierras, from which the river receives its water supply.

The slopes have been denuded both by lumbermen and forest fires, so that the coating of leaves and spills formerly covering the ground has been worn away until the clay of the soil has become exposed and washes away during heavy rains, and the particles thus set afloat are gathered in the streams and carried down into the Sacramento.

The destruction of these forests, too, has facilitated the melting of the snows in the higher altitudes, thus not only facilitating the washing process on the slopes, but increasing the floods that oftentimes come down in such volume as to overflow the levees, and on some occasions break large openings in their banks, flooding the adjacent country for miles, destroying property and driving dwellers to higher grounds for safety.

The levees along the banks of the Sacramento have been built of this same sand drift dredged from the bed of the river, and of course are not very substantial constructions. In places they have been strengthened on the inside faces by the use of rubble and willow matting.

Along the inner slopes of the levees also have been planted willows and other brush calculated to thrive in a moist soil, and the roots of these saplings do much to add strength to the banks.

The crests of the levees have been utilized as country highways, and the surfaces of these roads are now, to some extent, being coated with crude oil, which will add perhaps a little more to their stability.

But at best the Sacramento levees are not to be trusted, nor can the situation be said to be improving, as the channel of the river continues to fill with sand, while the floods appear to grow worse each year; that is, an increasing volume of water each year finds a decreasing channel for its outlet.

Much reclamation work has also been done on the Sacramento, and many overflow tracts, known as "inlands," have been surrounded by levees similar to those bordering the river, the water pumped out, and the lands cultivated.

These reclaimed lands have been found rich almost beyond belief, but the instability of the levees in many cases has led to heavy losses, and the building of so much additional dikeage has not improved the flood conditions on the Sacramento itself.

The question of navigation could perhaps be abandoned. Railroads could be constructed that would easily do all the carrying, but the question of drainage must be met, and the problems solved that are involved.

Some five years ago the situation was gone over by government engineers, and certain recommendations followed, but the matter appears to be in statu quo.

It was proposed that a very large amount of money be raised for the purpose of improving the river, one-third by the general government, one-third by California, and the balance by the tax-payers whose property would be directly benefited. Doubtless the scheme, whenever it shall take tangible form and substance, will be financed something after the fashion indicated.

The sand-drift question is to be a perplexing one. To remove the sand by artificial means is said to be an impossibility in consequence of its vast volume. Then it must be carried out by the current of the river itself; and when it is out of the river, there comes a question as to its disposal in San Francisco, Suisun, and San Pablo bays.

An old river captain suggests to me that it may be possible to handle the river question proper by constructing a dual bed; an upper and a broader one to carry off the flood waters, and a lower and a narrower one to carry off the sand and furnish a navigable stream during periods of low water. This would involve both extensive construction and the purchase of frontage land for widening the channel.

Again, the reforestation of the denuded Sierra slopes and the construction of vast storage reservoirs for irrigation purposes may possibly in time alleviate the situation to an appreciable extent.

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AN EARLY FRENCH ASTRONOMER.

BY J. E. GORE, F.R.A.S., M.R.I.A.

CONSIDERABLE interest has been aroused in the subject of comets by the recent "daylight comet," and the approaching display of Halley's comet; and some account of the French astronomer Messier, the famous discoverer and observer of comets, may prove of interest to the reader.

Charles Messier, who was called by Louis XV. "the comet ferret," was born at Badouville, in Lorraine, on June 26th, 1730. He was the tenth of twelve children. Before he reached the age of eleven he had the misfortune to lose his father. While still a boy, Messier had the opportunity of seeing the comet of 1744, which was remarkable for displaying a number of tails. He also observed the great eclipse of the sun which took place in 1748. This eclipse decided his career in favor of astronomy. In the year 1751, at the age of 21, he went to Paris possessing little or no recommendation, except a good handwriting and some skill in drawing. The famous astronomer Delisle engaged him to keep the register of his observations, and at first employed him in copying a map of the Great Wall of China, and a plan of the city of Paris!

Messier tells us in his Memoirs that from the end of 1753 he had become very experienced in his search for comets, a work which suited him best and to which, in fact, he practically devoted himself all his life. His curiosity about astronomical phenomena at this time was limited to viewing them merely as interesting spectacles; noting the time of their appearance and other circumstances connected with them, without the ambition of qualifying himself to calculate and predict their occurrence.

Messier worked for some time with La Grive on a plan of Paris and a map of France. On Delisle's return from a journey in Russia, he brought home with him a collection of books, manuscripts, and astronomical and geographical observations. These he presented to the Naval Office of Charts. The astronomical portion was afterward sent to the Paris Observatory. On account of this presentation, Delisle was appointed naval astronomer, and obtained for Messier the post of clerk of the office with a salary of £40 a year, to which Delisle added board and lodging.

Owing to an announcement from Berlin, Messier followed the comet of 1758 from August 15th to November 2nd of that year. He also observed the famous comet of 1759 (Halley's), the return of which Halley had predicted for that year. As at present, all the astronomers of that day were anxious to see the comet at the earliest opportunity in order to improve the orbit, which brought it back at intervals of 75 or 76 years. The calculations connected with its return gave the famous Clairaut an immense amount of labor. These calculations showed that the comet's arrival at perihelion would be retarded by the disturbing action of the planets Jupiter and Saturn, and he fixed the date of the perihelion passage for April 13th, 1759, with a possible error of 19 days. In those days these computations were novel and Delisle took the trouble to draw a map showing the different paths which the comet would follow in the sky according to the date of the perihelion passage. Other astronomers, including the famous La Caille, were occupied with other matters, and thought it rather a waste of time to watch for a comet which might possibly not return at all. Messier, however, acting under instructions from Delisle, kept a careful watch, and for nearly 18 months searched without success in positions which afterward proved to be incorrect. He might have been more fortunate had he been left a free hand in his observations, for the comet was first seen in Saxony on Christmas Day, 1758, by an amateur astronomer named Palitzsch. Some days later it was noticed by a doctor named Hoffman, and on January 18th, 1759, it was again discovered by a professor at Leipzig, who recognized it as the expected comet and computed its motion.

None of these observations, however, became known in France for several weeks, and it was only on January 21st, 1759, that Messier at last saw the comet. He kept secret his rather tardy discovery, and saying nothing about it to anyone except Delisle he followed the comet till February 14th, when it became lost in the sun's rays. At last Mayer informed La Caille and Delisle of the comet's return; and Delisle, seeing that the secret could not be kept much longer, allowed Messier to speak of his observations, and to tell the secret to the other astronomers. This tardy information was not, however, well received by them, and they

rejected the assistance given with such bad grace, and not with the authority they thought necessary in such a new and important research. They were not satisfied with Messier's observations and looked forward with emulation to observing the comet themselves after it had emerged from the sun's rays in the beginning of April. Delisle, however, acted in the same way with reference to another comet discovered by Messier on January 21st, 1760. This conduct seems to be unintelligible, as Delisle did not calculate any orbit and deserved no credit for observations which he took exclusive possession of. This was very different from other astronomers, who, fearing that bad weather would interfere with satisfactory observations to enable them to compute a good orbit, hastened to announce publicly discoveries of this kind.

About this time, Delisle having given up science and the chair of astronomy at the Royal College to enable him to devote himself entirely to religious work, Messier was left alone to his own devices, and occupied himself with his favorite researches with greater zeal and success. During 15 years almost all the comets which were discovered were found by him. In fact he spent his life in discovering comets, and the maps which he drew of their paths were considered very accurate. The height of his ambition was to become a member of the St. Petersburg Academy. He was a man with the simplicity of a child. A story is told of him that when his wife died the care which he bestowed on her during her last illness was the cause of his missing the discovery of a comet which Montaigne had found. The loss of this comet weighed upon his mind, and when some friends consoled with him on the loss of his wife he said, "Alas! I had discovered twelve comets and this Montaigne has robbed me of the thirteenth!" And he wept; then remembering that it was his wife he should weep for, he said, "Ah, that poor woman!" and continued weeping—for his lost comet!

He sent one of his comet maps to the King of Prussia, who at once requested the Berlin Academy to elect him as a member. He was also elected a member of the Academy of St. Petersburg.

As his reputation increased, so did his very moderate income. His title of "Clerk" was altered to that of naval astronomer. Each of his cometary discoveries procured his election to a foreign academy. He was several times proposed for the French Academy; but for a long time without success. He was reproached for being too exclusively addicted to observations to the neglect of calculation and theory. They might have made the same objection to the famous Tycho Brahe! He was less severely judged by the rest of Europe, and after the death of La Caille he was universally regarded as the leading astronomer of France. Gradually, however, the Paris Academicians became reconciled to the idea of admitting a mere observer to their august body, and he was at last elected in 1770.

It must be admitted that Messier did all he could with the means at his disposal. With merely good eyesight, an excellent small telescope, a pendulum, and a quadrant, what more could be expected of him but observations of comets, eclipses, and other celestial phenomena? All his discoveries of comets were made with a 2-foot telescope of only 2¼-inch aperture magnifying about 5 times, and with a field of view of 4 degrees.

Messier's comet maps did not help in the calculation of orbits. They were too rough for this purpose. Only once did Messier venture to give the elements of a comet's orbit. It was that of Halley in 1759, the orbit of which had previously been computed by La Caille, Lalande, and Maraldi. It has been found that if we take the arithmetical mean of the elements found by these three astronomers, we find very nearly the system of elements found by Messier and presented to the French Academy. This seems a curious coincidence if we consider that Messier claimed that his orbit was deduced by calculation from his own observations.

Messier was anxious to follow the planet Uranus, which was discovered by Sir William Herschel on March 13th, 1781. This discovery, which was then unique in the annals of astronomy, was announced to Messier by Maskelyne, the Astronomer Royal of England. For about a year Messier zealously followed the course of the new planet, when a very serious accident happened to him which interrupted his labors for a long time, and indeed had a permanent effect on his future work. As he was walking one day, November 6th, 1781, with the president of the academy, M. Saron,

in the gardens of Monceaux, he went to see a grotto which attracted his attention. An open door seemed to be the entrance to another grotto. But this was an ice house, and, proceeding incautiously, he fell a depth of 25 feet on a heap of ice. He broke his arm and thigh, injured both his sides, and received a wound on his head which bled profusely. It was with difficulty that he was extricated, and, notwithstanding the skill of a well-known surgeon, a fellow-academician, his recovery was tedious and the cure imperfect. Disgusted with surgery, he placed himself in the hands of Dumont, who broke his arm anew in order to set it better, and confined him to bed for several months. He received much sympathy from his friends in his misfortune. His colleagues, Saron, Boscovich, and Sage, were especially solicitous for his recovery. Sage obtained for him a pension and a gratuity. It was not till a year after his accident that he could return to his observatory to prepare for observing the transit of Mercury, which he observed on November 12th, 1782. Having become an academical pensioner, he saw with dismay the suppression of the academy in 1793 by the revolutionary leaders. His pension ceased, and even the payment of the rent of his observatory at Cluny was discontinued. He continued, however, to reside there, and did not alter his habits. Fortunately, he could exist on his savings, as he was very economical and managed to live on his very moderate income. It appears, however, that his resources were very limited, for he could not find means for lighting the lamps which he used in his nightly observations, and on several occasions he was obliged to appeal to Lalande for some oil!

In September, 1793, he discovered a new comet in the constellation Serpentarius. The astronomers of Paris were then dispersed owing to "the reign of terror." Saron alone remained. Messier sent him his observations. From these Saron calculated an orbit; but a few days later he was arrested and executed.

Soon after this, however, Messier experienced better times. The Institute, the Bureau of Longitudes, and the Legion of Honor, to which bodies he had been elected, came to his assistance and restored with interest his financial losses, thus placing his family in comfort. On the death of his children, a niece of his, Madame Bertrand, came to live with him, and during the last 19 years of his life paid him every care and attention. He continued in good health up to the age of 82 years, and then his strength began to fail. He could only read and write with a strong magnifying glass, which much fatigued him. After some time he had an attack of paralysis followed by dropsy, and died on the night of April 11th, 1817, at the good old age of 86 years.

Messier did not write any books on astronomy. He left nothing but memoirs in which he gives an account of his astronomical and meteorological observations. These are scattered through the volumes of the French Academy proceedings and those of the *Connaissance des Temps*. He made many observations on sun spots. Some of these were made at intervals of three days, which should have been sufficient to determine the period of the sun's rotation on its axis. But an examination of these records gave discordant results. This may possibly be due to "proper motion" in some of the spots he observed.

When Lalande published in 1775 a new celestial globe he named a small constellation after Messier. This was formed from some small stars scattered between the constellations Cepheus, Cassiopeia, and Camelopardalis. But in modern maps and globes this group of stars is ignored.

Messier showed on every opportunity how little respect he had for theories, and he seems to have valued nothing but practical observations. He might well have been asked, What is the use of collecting a large number of observations if we have no theory in view? When he had observed a phenomenon, and when either by an error in the tables or by the mistake of the computer he found some difference between theory and observation, he seemed to delight in pointing out the discrepancy.

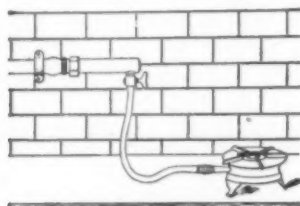
In his search for comets, Messier discovered several nebulae, and to assist in the discovery of his favorite objects he formed a catalogue of the nebulae known in his time. In the year 1771 he published a catalogue of 68 nebulae in the Memoirs of the French Academy. In the years 1781-1782 this list was republished in the *Connaissance des Temps*, and 35 other nebulae were added, thus bringing the total up to 103 nebulae. Many of the nebulae are still known by their number in this catalogue.

SOME SIMPLE NEW INVENTIONS. "S

SUGGESTIONS OF MANY KINDS.

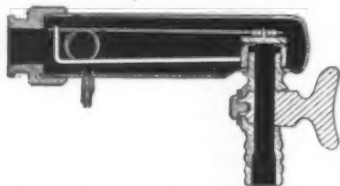
A DEVICE FOR PREVENTING ASPHYXIAION BY ILLUMINATING GAS.

ILLUMINATING gas is not very dangerous because its presence, even in very minute quantities, is immediately revealed by a strong and characteristic odor, yet terrible explosions and fatalities occur from time to time, and an automatic device for their prevention would be very useful. One such device, invented by



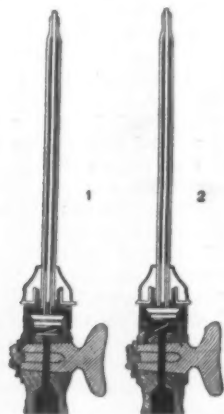
GAS STOVE WITH ROTH SAFETY CONNECTION.

Roth, is designed especially for use in connection with gas stoves, Bunsen burners, and other apparatus, in which India-rubber connecting tubes are used. With apparatus of this kind, accidents are of comparatively frequent occurrence, owing to the accidental disconnection of the rubber tube at night when the burner is lighted, or to the leakage of old and worn tubes. The Roth safety device consists essentially of a horizontal copper cylinder, into which the gas is admitted at one end, while a vertical copper tube is inserted through the lower face near the other end. This vertical tube is provided with a stop cock and ends below with a nipple for a rubber tube. The safety mechanism is contained in the cylinder. It consists of a copper valve, which is attached to a flexible rod and is placed immediately above the open top of the vertical efflux



ROTH SAFETY CONNECTION FOR GAS STOVES.

tube. With this arrangement, any appreciable increase in the outflow of gas produces an aspiration, which closes the valve and entirely cuts off the flow. After the valve is closed, the pressure of the gas behind it prevents its reopening, as long as the stop cock remains open. In order to use the gas again, it is necessary to close the stop cock and reopen it. Sometimes it is necessary to give the whole apparatus a slight shake. With this arrangement any leakage causing a sudden increase in the outflow of gas will have the effect of shutting off the supply. The only conditions necessary are that the apparatus shall be placed in an exactly horizontal position and that the rubber



ROTH SAFETY GAS BURNER.

1. Opened by expansion of rod. 2. Closed by contraction of rod.

tube shall be exactly fitted to the copper outlet tube. Roth has also devised a very ingenious safety gas burner. Sometimes the gas is turned off at the meter without being turned off at the jet. In such a case another person may turn on the gas at the meter for the purpose of using another jet, and may thus allow gas to escape into the room from the jet which is already open but not lighted. In the Roth burner the gas flows into a small closed chamber, from which it

cannot escape until a rod, which threads the burner lengthwise, has been expanded by heat. If for any reason whatever the flame has been extinguished, the flow of gas is cut off automatically by the contraction of the rod, the lower end of which is attached to a valve, which closes the gas chamber. To light the burner it is necessary to turn the stop cock beyond the vertical position, thus opening a lateral passage, by which the gas can reach the jet, or the incandescent mantle. In a few seconds the central rod is heated, the valve is opened, and the gas continues to glow and to burn, even after the stop cock has been brought back to the vertical position. When the flame is accidentally extinguished, however, the flow of gas is automatically cut off.—La Nature.

A REGULATOR FOR ELECTRIC AUTOMOBILE LIGHTS.

SERIOUS difficulties are always encountered when a dynamo is driven by a motor of varying speed, for even a compound-wound dynamo will not furnish a current of constant voltage and amperage unless its velocity of rotation is pretty nearly constant. The speed of an automobile motor varies from 150 to 1,500,

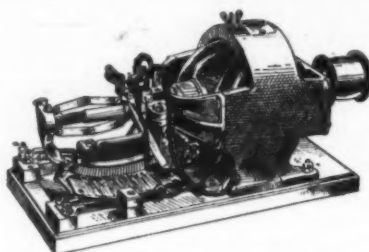


FIG. 1.—DYNAMO AND REGULATOR.

that of a hydraulic turbine from 20 to 100, and that of a windmill from 0 to 100 revolutions per minute. A lighting dynamo driven directly by any of these motors gives a very unsteady light, and ruptures of lamp filaments occur frequently, unless a very sensitive and quickly acting regulator is employed.

A French inventor, M. Eyquem, has solved the problem of the electric lighting of automobiles by providing a small dynamo of 120 watts capacity with a centrifugal regulator, which connects and disconnects a 12-volt storage battery and also regulates the magnetic field of the dynamo by inserting in the field circuit a resistance which varies with the speed of the motor. This device keeps the voltage absolutely constant within wide limits of variation of speed. The regulator consists essentially of two heavy masses which revolve about a horizontal axis and are connected by a spiral spring. This centrifugal governor, driven directly by the shaft of the dynamo, moves a lever, one end of which connects and disconnects the storage battery, while the other end makes connection with the contact pieces of a set of resistance coils. The dynamo starts with the battery disconnected, but when the motor has attained a certain speed the battery is connected and the current thenceforth flows into it. The volume and voltage of the current are regulated by the movement of the lever over the field rheostat.

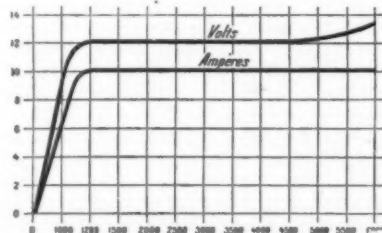


FIG. 2.—VOLTAGE AND AMPERAGE AT VARIOUS SPEEDS.

The diagram (Fig. 2) shows that the strength of the current remains equal to 10 amperes while the speed increases from 1,200 to 6,000 revolutions per minute, and that the tension remains constant at 12 volts up to 4,500 revolutions and rises only to 13.5 volts when the speed is increased to 6,000 revolutions per minute.

A dynamo, storage battery, and regulator of this type will operate the headlights, sidelights and interior lamps of an automobile, including a movable lamp for use in repair work at night. The headlights should be provided with parabolic reflectors, without lenses. The storage battery, furnishing 12 volts and 80 amperes, can be placed in one of the lockers of the car. The dynamo may be driven by a belt, or by a toothed wheel or friction wheel on the flywheel of the

motor. The power absorbed is about $\frac{1}{4}$ horse-power, costing less than 2 cents per hour. Hence this method of lighting automobiles is the cheapest as well as the best.

This very simple mechanical regulator appears to furnish a satisfactory solution of the problem of ob-



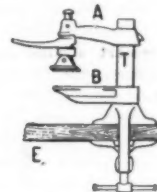
FIG. 3.—DETAILS OF REGULATOR.

A. Make and break plug. BB. Governor balls. R. Rheostat contact.

taining electric light from windmills, and especially from hydraulic turbines which drive various machines in addition to the small lighting dynamo. These conditions exist in most rural installations, where electric lighting has hitherto been impracticable, owing to the lack of a simple and reliable regulator.—La Nature.

THE MULTIPLEX OR UNIVERSAL VISE.

THE multiplex is a new French implement which is designed to take the place of the various vises, jacks, and other tools which are employed by carpenters, joiners, locksmiths and other workers in wood and metal, for the purpose of holding rigidly in place the object or material that is being operated upon. The multiplex is of very simple construction, as the drawing shows. It consists of a steel rod T, which can be



THE MULTIPLEX.

attached by a screw clamp to the edge of a table or a plank, and of two transverse pieces, A and B, between which the object can be securely clamped by turning the lever connected with the piece A. The multiplex vise can be attached to a work-bench, a table, a box, or even a carriage step. It occupies little space, is quick-acting and will be found particularly useful to automobilists and amateur artisans.—La Nature.

CASTOR ATTACHMENT FOR FURNITURE.

THE Invisible Castor or "Dome of Silence" is a simple and inexpensive device which makes it possible to move furniture easily and silently by sliding, without injuring carpets, rugs or floors. This novel castor is a little cup, or cap, of sheet metal, having three sharp prongs at its rim. It is easily attached to the foot of a table or chair by tapping with a small hammer. With heavy furniture the process is still simpler. Each foot is raised, in succession, an inch from the floor, and the castor is slipped under it, with the prong



THE INVISIBLE CASTOR.

directed upward. When the foot is let down the prongs are driven in by the weight of the piece of furniture. A set of four castors is sold in Paris for 12 cents.—La Nature.

Bronzing Cast Pewter Articles.—Cleanse the objects and wash them with a mixture of 1 part of green vitriol and 1 part of blue vitriol in 20 parts of water. Dry them and then wash them in a mixture of 4 parts of verdigris in 11 parts of distilled wine vinegar. After drying, polish with crocus.

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"STELLITE," A NEW ALLOY.

A REMARKABLE METAL.

BY ELWOOD HAYNES.

THERE has been much research and discussion regarding the material used by prehistoric man in making tools. The earliest forms of implements were probably made of stone, but whether a "bronze age" intervened between the age of stone and that of iron, is open to serious question.

Certain it is, however, that a good cutting tool was essential to the progress of the race, and heretofore, iron, in the form of steel or other combinations, was the only metal which was capable of being formed into a good edge tool. The facility with which it may be worked, and the fact that it may be given different degrees of hardness by tempering, has rendered it the metal *par excellence* for cutting tools. There is just one serious objection to steel, however, as an element for cutting instruments, and that is its susceptibility to corrosion or rust. No matter how highly finished the tools may be, which are made of this substance, constant vigilance is necessary to protect them from rusting.

There has been much discussion regarding the conditions which bring about the rusting of iron and steel, but it is not my purpose to consider these conditions, but to consider a new alloy which not only rivals steel in cutting qualities, but also possesses a resistance to atmospheric influences which is perhaps equaled only by gold and the metals of the platinum group.

The metals cobalt and nickel have always been of much interest to the chemist. Their compounds are very similar in their chemical behavior, and if solutions of these metals are mixed, it is very difficult to separate the metals, one from the other. This is because their behavior is almost identical under the influence of various reagents, and chemists will gladly welcome any new and more efficient method of separating these metals. The compounds of these elements were known before the metals themselves were isolated. It has been known for centuries that certain substances would impart a blue color to glass, and this power was doubtless due to some form of cobalt.

The name "Cobalt" has a somewhat mythological derivation. The early German miners encountered its ores in mining copper, but as they were not able to obtain any copper or other useful metal from these ores, they supposed that the goblin, or evil spirit, had exercised a harmful influence upon the ore. This evil spirit was called by the Germans, the "Kobold," and from this designation, the word "Cobalt" was derived. The metal nickel has suffered a similar fate, its name having been derived from "The Old Nick," meaning a devil.

In 1751, Cronstedt succeeded in producing impure,

in the form of wire was found to be about 52,000, and that of cobalt about 65,000 pounds per square inch. Both metals, therefore, showed a tensile strength superior to that of pure iron. As nickel was the more abundant metal, it at once took the precedence over cobalt, and the latter metal was kept in the background for a great many years. In fact, it has never



THE CENTER TOOL IS MADE OF STELLITE; THE OTHER TWO OF HIGH-SPEED STEEL.

The photograph shows the effect of cutting a bar of steel running at very high speed in a lathe.

attained any prominent use in the arts, either in the pure form, or as a constituent of alloys. Its nitrate and chloride have been used to a considerable extent; the former for detecting free alumina in minerals, and the latter for making the so-called "sympathetic ink." The compounds of cobalt have also been used for making the pigment known as cobalt-blue, which is obtained by heating a mixture of the recently precipitated oxides or phosphates of aluminium and cobalt, to redness in a crucible. The oxide of cobalt is used for imparting a blue color to glass and glazes. With these exceptions, there has been but little use for the compounds of cobalt.

When, therefore, the arsenide was found in large quantity in and about the town of Cobalt, Ontario, in connection with the mining of silver, an over production of cobalt ore soon occurred, as this substance became a by-product in the mining of silver. An outlet for this material was sought in vain, as no practical use could be found for either the metal or its compounds, aside from those mentioned above.

About the year 1835, I made some tentative experiments relating to the production of alloys of nickel with iron, chromium, etc. The fusions were made in small graphite crucibles by means of a small gas furnace of the Fletcher type. Temperatures ranging to the fusing point of fire clay were readily obtained, and by this means I later succeeded in making alloys of nickel and chromium containing small amounts of carbon and silicon. A few years later I made an alloy of this description to which was added a small amount of aluminium. The metal was hard and rather brittle. It could not be worked under the hammer either hot or cold. I made from it, however, a pocket knife blade which was ground into final shape. It showed fair cutting qualities, and considerable resistance to atmospheric influences. It was readily soluble in nitric acid, and after long exposure to the atmosphere of the chemical laboratory, it showed a green tarnish.

I finally succeeded in producing an alloy of pure chromium with pure nickel by heating the mixed oxides of these metals with pure powdered aluminium. The reaction was so violent that the greater part of the alloy was thrown from the crucible. Some particles were saved, however, which showed great malleability, and after grinding off on a carborundum stone, and afterward polishing, they exhibited a fine luster. I did not make a quantitative analysis of this alloy, but a chemical examination of it showed that it contained chromium in considerable quantity.

Shortly afterward I repeated the same experiment with cobalt oxide and aluminium, and obtained much the same result, except that the particles were much harder. To my surprise, however, notwithstanding their great hardness, they showed considerable malle-

ability, and it occurred to me that the alloy would be suitable for cutlery, if it could be obtained in sufficient quantity.

Shortly after making these experiments I was called actively into the automobile business, and did not make further experiments on either of these alloys for the next three or four years. I then took the matter up for ignition metal, and succeeded in making both alloys in considerable quantity. Owing to the difficulty of fusing the cobalt-chromium alloy, and to the fact that it absorbed carbon from a graphite crucible, I was obliged to make up a special crucible which would withstand an extremely high temperature, and was also free from carbon. The fusions were first made in an electric furnace, but afterward I succeeded in melting the metal in a small furnace of special construction, operated by natural gas. After some experimenting I became able to melt the metal to a perfect fluid, and cast it into bars ranging from $\frac{1}{4}$ inch to $\frac{1}{2}$ inch square. I found that the metal worked readily at a red heat, though it showed a tendency to check at the edges when hammered out into strips.

After some experimenting, I was able to produce metal that would forge out perfectly into thin strips, which showed no tendency to check. After cooling, these strips were as hard as mild tempered steel, and could scarcely be scratched by a file. A kitchen knife blade was made from this material, and used for all sorts of purposes, such as are known only to the culinary art. After two years of use, it showed not the faintest sign of tarnishing, and if held in the sun, it produced a reflection that would dazzle the eye.

PHYSICAL PROPERTIES.

In color, the metal stands between silver and steel, and if suitably polished, it shows a high luster. I have thus far made no physical tests of the forged metal, but a cast bar showed an elastic limit of 79,000 pounds, an elongation of 3 per cent, and an ultimate strength of 96,000 pounds to the square inch, cross section. A test was also made of the modulus of elasticity of the material, which was found to be fully equal to that of steel. These tests were made on one of the first bars produced, and I am pretty well satisfied that much higher results could now be obtained.

Notwithstanding the fact that pure cobalt is decidedly magnetic, the 25 per cent alloy shows not the slightest attraction for the magnet. With just what per cent of chromium the magnetism disappears, I have not yet determined.

Notwithstanding the great hardness of the alloy, it not only forges readily at a red heat, but can be bent at a right angle cold, either in the form of a cast or

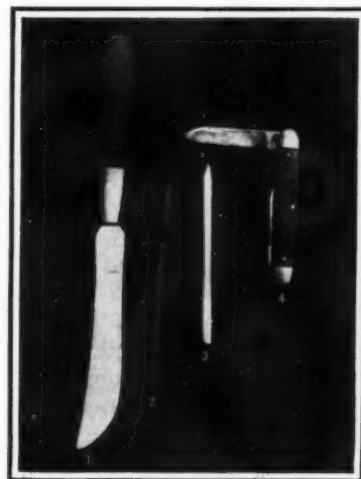


STELLITE LATHE TOOL AND SHAVINGS.

Shavings cut from a bar of steel running at such a high rate of speed that high-speed steel failed quickly.

metallic nickel, and in 1776 it was pointed out that the Chinese alloy, known as "Packfong," contained nickel. About 1823, the composition known as German silver was first made, with nickel as a prominent constituent, and in 1857, the celebrated French chemists and metallurgists, Deville and Debray, prepared both nickel and cobalt in the pure state by heating the oxalates of the metals in lime crucibles.

Both possessed high tensile strength, and showed fine color and luster. The tensile strength of nickel



1, Stellite steak knife; 2, nail cut by chisel shown in 3; 4, stellite pocket knife.

forged bar, provided the dimensions do not exceed one-fourth inch square. Its elastic limit is not quite equal to that of tool steel of the same hardness, but it is much tougher. Samples can also be made showing much greater hardness than those described above, but the breaking strain and elastic limit will, under these circumstances, closely coincide.

Blades made from the alloy take a fine cutting edge, which is particularly smooth, though capable of excellent cutting qualities. A razor was made of the cast material, which has now been employed for

nearly two years, and has been used for shaving purposes hundreds of times, but shows no signs of wear. It is not equal to a good steel razor, since it requires more frequent stropping. It takes, however, a very smooth, keen edge. I am satisfied that the metal I am now able to make would show considerably better results for this purpose.

While I do not recommend the alloy as yet for cutting metal, it has shown some remarkable capabilities in this line, especially for a nonferrous alloy. A small chisel, about one-fourth inch square, will readily cut a twenty-penny wire nail in two, without marring the edge of the tool. A lathe tool made from the alloy with certain modifications, is capable of cutting ordinary steel at a very high rate of speed. A test was made against high speed steel, and it was found that the Stellite tool would cut a continuous shaving from the bar, at the speed of 200 feet per minute, while the high speed alloy steel tools failed almost instantly. It does not of course follow from this that the alloy is better suited for high speed lathe tools than good alloy steel, but simply that it will stand a higher speed without "burning."

The coefficient of expansion of the alloy has not yet been determined, but it is probably quite low, approximating pretty closely that of glass, since a small Stellite wire can be sealed into a glass tube, making an air-tight joint, without cracking the glass.

VARIETIES OF THE ALLOY.

What has been said above relates principally to the alloys of cobalt and chromium, containing approximately 75 per cent of the former, and 25 per cent of the latter metal. A great variety of alloys can be obtained by varying the percentages of the constituent metals, as well as by adding small quantities of other substances. I have prepared alloys of cobalt and chromium containing as high as 20 per cent platinum, but have found that they do not resist chemical reagents so well as binary alloys of cobalt and chromium. I have produced non-oxidizable alloys, proof against nitric acid, which were so soft that they could be readily filed. Other modifications of the alloy are so hard that they will readily scratch glass, or even quartz crystal. These latter, however, are most of them rather brittle. Between these two extremes a great variety of alloys may be formed which are suitable for various purposes, according to requirement.

CHEMICAL PROPERTIES.

More than ten years ago I discovered that the alloys of both cobalt and nickel with over 10 per cent chro-

mium were practically proof against nitric acid of all strengths, hot or cold. A brightly polished piece of the cobalt-chromium alloy is attacked slowly by cold, strong hydrochloric acid, and after the lapse of a few seconds, the solution shows a faint greenish tint. The action, however, does not become violent, unless the acid is heated, in which case it becomes somewhat vigorous. The more dilute the acid, the slower its action, and the alloy may be momentarily exposed to the action of the dilute acid without perceptible effect.

Either strong or dilute sulphuric acid attacks the metal very slowly. It is a singular fact that if a small amount of potassium bichromate be mixed with the sulphuric acid, the action is almost nil. Just why this is true is somewhat difficult to understand, since under these circumstances, a mixture of chromic and sulphuric acids is produced, which usually shows very violent oxidizing properties.

Hydrofluoric acid also acts very slowly on the alloy, and its action seems to be similar to that of hydrochloric acid, though not so pronounced. With the exception of the above acids, the alloy is practically inert to all other chemical reagents. A polished piece may be boiled in nitric acid for hours without having its luster diminished in the slightest degree. The alloy may also be boiled in solutions of the caustic alkalis for an indefinite length of time without the slightest effect. It is likewise proof against all atmospheric influences, and will retain its luster under all circumstances, no matter whether the atmosphere is dry or moist, or even heavily laden with acid vapors, sulphureted hydrogen, or other corrosive gases. It may be placed in saline solutions of the caustic alkalis and allowed to remain for days, or until the solution completely evaporates, leaving the metal imbedded in the solid residue, without the slightest effect. It is likewise proof against all the articles commonly used for food, such as eggs, boiling solutions of salt and vinegar, pickles, prepared mustard, etc. Mention has already been made of the knife which, after a test of more than two years in the kitchen, still retains its original luster.

When the 25 per cent alloy is heated in the air, it retains its luster up to a temperature of about 350 deg. C., and then assumes a pale yellow color which, as the temperature rises, gradually deepens, becoming full yellow, orange, purple, and finally blue-black, after which it may be heated to whiteness without further change. It never shows the slightest tendency to scale

when worked under the hammer, and while a finished hammered bar shows a dark, blue-black color, it also presents a glossy surface, provided the hammer used in drawing it had a smooth surface. This film of oxide seems to prevent the bar from further oxidation. As already stated above under *varieties*, the properties of the alloy can be considerably altered by making slight changes in the composition. One variety, which is thus far only adaptable for castings, is almost as inert as platinum, up to a full red heat.

USES.

Primarily, the metal will probably find its widest use as a material for small cutlery, such as pocket knives, table knives, fruit knives, carvers, etc., since it takes a good cutting edge and retains its luster under all circumstances. If suitable ground and polished it presents a beautiful white and lustrous surface, and while its color is not quite equal to that of silver, it is always permanent and agreeable to the eye. Combined with this permanence and beauty of finish, it possesses cutting qualities comparable to those of good steel. It also holds a permanent edge, and seldom requires sharpening.

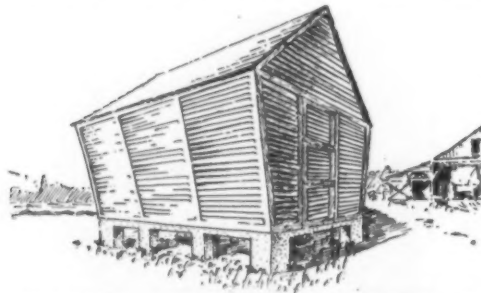
Blades made from this material may be used for cutting fruits of all kinds without being effected in the slightest degree. Even if the fruit acids are allowed to "dry on," it is only necessary to wash the blade, and its full luster will appear.

The alloy is also well suited for the manufacture of surgical instruments, since it is not at all affected by mercuric chloride or other sterilizing solutions which severely corrode steel instruments. It will also probably have considerable application in dentistry and watch making. For instruments to be used in the chemical or physical laboratory, it is the material par excellence. The writer knows from experience that it is a great satisfaction to have spatulas, scrapers, and other tools remain perfectly bright in the chemical laboratory. As a material for balance beams, weights, etc., it leaves little to be desired. It is especially suited for weights, since it is both hard and untarnishable, and can readily be worked into the proper form. It is admirably adapted, also, to the manufacture of fine standard weights and measures for government use, and it is hard to see in what respect it is inferior to the expensive platinum-iridium now employed for this purpose.

It could also be manufactured into cooking utensils of the most excellent quality, and its use for this purpose is only limited by its cost.

CONCRETE CORNCRIB AND GRANARY FLOORS.

RATS destroy grain, carry "catching" diseases from house to house, and from their love of matches cause destructive fires. This useless waste has become such a national loss that the Department of Agriculture at Washington, D. C., has issued a free bulletin on "How to Destroy the Rat." To get rid of the rat remove his nesting place. With this object in view the Department recommends concrete floors especially for barns, poultry houses, corn cribs and granaries. The experience of many farmers is, that grain mature enough to be placed in storage will not spoil on concrete floors.



CORNCRIB, BARN AND FEEDING FLOORS AND WATERING TANK.

Says the government bulletin, "Corn will not mold in contact with them, provided there is good ventilation and the roof is tight."

For a corn crib choose a well drained site. Excavate a trench for an 8-inch concrete foundation wall around the outside of the building and to the depth of 2 feet. With box forms of 1-inch siding on 2 by 4-inch studding, carry this 8-inch wall to a height of 12 to 18 inches above ground level, depending upon the height of the drag-belt conveyors used by local corn shellers. (All concrete floors should rest on a fill bringing them entirely above the surrounding ground.) See that the forms line up and test them for levelness.

On a tight mixing board mix the concrete 1 part Portland cement to 2½ parts sand to 5 parts crushed rock (or 1 part Portland cement to 5 parts bank-run gravel), all measurements by volume, based on 1 bag of loose cement being equal to 1 cubic foot. Fill the forms with concrete thoroughly wet and do not remove them for 4 days.

There are several ways of attaching the studding to the concrete floor. One of the simplest and easiest is the nailing sill or plate, generally a 2 by 6-inch piece, bolted to the concrete foundation wall. For such a sill, while the concrete is still soft, set ¾-inch bolts 8 to 10 inches long, head down, 3 inches in from the outer edge of the foundation wall and projecting 2½ inches above the concrete. These bolts should be spaced not more than 3 feet apart.

Some farmers prefer to counter-sink the nailing sill so that its top will be flush with the surface of the floor. So placed, the sill is liable to rot more quickly. Others firmly imbed strap loops, made of old wagon tires, with the loops ends encircling the studding. Do not sink the wooden uprights into the concrete. Timber rots out in a few years; concrete lasts forever. Sometimes studs so placed swell and crack the concrete.

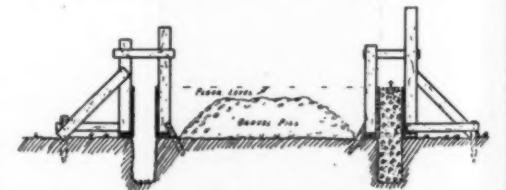
After the forms are removed, place a well rammed fill between the foundation walls and within 4 inches of their tops. Coarse gravel and crushed rock are the best materials for this purpose. If some clay must be used, tamp it in the bottom, but let the floor rest on at least 6 inches of gravel or crushed rock. With the fill thoroughly settled, commence placing the 4-inch floor. This concrete should be only wet enough so that it will flush a little liquid cement when tamped into place. Begin at one end and lay the floor crosswise in 3-foot sections. Bring the surface of the floor flush with the top of the foundation wall and, with a straight edge, round it up slightly (say 1 inch) in the center. Dress it down with a wooden float and, when the cement begins to stiffen, smooth the surface with a steel trowel. Continue placing the floor in sections until the work is completed. Build the floor early enough in the season so that it may be thoroughly dried out before grain is stored on it.

Experienced concrete workers often use only an outside board form, one wall, for the foundation walls. They place the concrete for the foundation wall against this outside form and at the same time tamp the gravel fill back of the concrete. In this case the foundation, as well as the floor, is built in sections and both at one time. The saving in lumber so effected really amounts to nothing, as all the boards can be used later in the crib.

Reinforced concrete floors, not supported by earth or gravel fill, but by the foundation walls alone, can be and are being successfully built. Since the strength of each floor, on account of the variation in size and

loading, is a different problem, it is advisable to refer every piece of such work to a man who is thoroughly familiar with the principles of reinforcing. The main point is that concrete floors last forever. They afford no nesting place for rats. And with \$1.00 wheat, 75 cent corn, and 50 cent oats, the saving thus effected adds considerable to the profits of each year.

The Baden railroad company in Germany has adopted a very efficient method of handling milk in shipment. In certain stations of this railroad where the passenger trains transport the milk in the rear cars, there are loaded each time about 70 milk cans of 6 gallons each, and even when six employees are



PLAN OF THE FLOOR.

engaged in the loading, this takes as long as four minutes, thus giving a considerable loss of time per train. To overcome this, the milk cans are grouped by 12 in a frame mounted upon rollers, and three of these frames can be placed on a special type of four-wheeled station truck, designed so that the sides can be let down so as to make a bridge to the floor of the car. The milk cans are loaded on to the small frames beforehand, these being placed on the truck so that the frames can be readily pushed into the car. It was required to design the rollers of the frames so that one man can always operate them, and to this end they are mounted in ball-bearings and can be run in any direction. Before this it took from 1½ to 2 minutes to load the 36 cans from a truck to the car, but now it requires but 15 or 20 seconds, so that at each station there is gained 2 or 3 minutes which is quite appreciable. Outside of the question of time, the new method has an advantage in that there is less damage to the milk cans when they are handled empty, as they are not thrown upon the ground when unloaded, as before. The cans are now replaced in the frames and so handled in all cases, being classed by stations. The unloading is thus carried out to a great advantage.

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BRONZING.

TREATMENT BEFORE BRONZING AND DURING THE BRONZING PROCESS.

THE following directions for the treatment of objects before bronzing, and for the bronzing process itself, are given by Joh. Rhein, an authority on mechanical-metal coloring, in his book, "Der Geübte Bronzeur."

Small objects of cast or wrought iron must be smeared over very thinly with linseed oil, and heated over a coal fire until the oil has penetrated the surface and any residue has been burned away; to obtain a brown ground-tone, add a little green cinnabar to the oil.

The oil, by penetrating the outer porous stratum of the iron, protects it from rust; but there must be no soft solder on any part of the objects; and old, rusty articles must previously be cleaned with a scratch-brush, or boiled in a strong lye of calcined soda, and cleaned with a stiff brush. If the strength of the metal, the form, etc., will allow, anneal them gently before the scratching or treatment with the lye.

Old articles of cast zinc or other metal, which have been once bronzed or lacquered, are to be treated with soda lye, and if this is not sufficient, rub any special places with a mixture of alcohol and turpentine oil.

In the case of new zinc, it is of advantage to color the objects dark, before bronzing, with water saturated with hydrochloric acid; small articles can be dipped into the fluid, larger ones can have it smeared over them. The water can be so acidified, that the objects will become blue-black; but care must be taken that the bath is not strong enough to decompose the zinc; and the objects should be left in it but a short time, so that only the outer stratum is attacked. If the bath is sufficiently strong to bring out a very dark color, the objects should be rinsed in a quantity of water.

New iron pieces, parts of machinery, etc., whether dry or wet polished, should be put in a hot place as soon as finished, and allowed to change color, or else be gently annealed, before burning in the oil. Polished or smooth surfaces in general must be smeared over very thinly with the oil and wiped off gently with a cotton rag, so that no spots of oil or threads of dust may be left after burning. In the bronzing process, or in shading, a somewhat heavier coat should be applied than would seem at the moment desirable, for the reason that the coloring will show less after a while than at first.

All bronze coatings upon which the polishing leather is to be used, must have a basis of rather oily copal

lacquer; such cases are especially those of objects which are to be inlaid. The leather must be warmed before use, as the result will be less satisfactory without any artificial heat. Never apply to silver a brush which has been used in bronzing gold or copper, or the reverse, without thoroughly cleaning it in warm soda solution and soft soap; varnish and oil brushes must be cleaned with turpentine, and all kinds of brushes cleaned frequently, putting them into pointed shape with the hand after the cleaning.

Brushes which are used only occasionally can be kept soft by leaving them in a cylindrical vessel, into which remnants of varnish are poured from time to time, and the fluid kept thin with turpentine oil. All brushes should be adapted in size to the surface upon which they are used. Bristle brushes for bronzing should be soft and blunt pointed, and not too short, otherwise both bronze and varnish will suffer and the object will lose in luster. In bronzing, the brush should be turned around in the fingers, so that the coating will be even and the brush keep its rounded shape.

In shading, that is, in bronzing the raised portions more heavily and the depressions more lightly, the brush must always be moved diagonally over the raised parts, lines, contours, etc., so that it will touch them with greater force than it does the others, and thus give more bronze.

Vessels for varnish should be cylindrical in form, so that the brushes can be easily dipped in, and should not be too narrow; cast iron ones are preferable, as in this case the residue of the varnishes, resins, etc., can be removed by heating.

In bronzing, hold the object by some part of it which will be the least liable to injury and do not grasp it first here and then there, as this will be detrimental to the appearance.

Feeling of the objects, to see if it is time for the bronzing, should be done with the tips of the fingers. The right time is when the varnish is hardly at all sticky, that is, when it offers but a very little resistance to the touch.

The principal point in bronzing is to take up just the right quantity of turpentine oil upon the brush. If there is too much, the bronze will lose its luster and the work its beauty; with too little, the brush will not hold the bronzing powder; this will be deposited in the depressed portions, and the work will equally suffer.

In beginning, unfold the packet of bronze powder,

and put weights on the ends of the paper to hold them flat. Then let one or two drops of turpentine oil (according to the size of the brush) fall on the glazed paper; and moisten the brush by rubbing it in the oil. Take up a little of the powder on the brush, and rub it in evenly, then pass the brush once or twice over the palm of the hand or a piece of paper, to make the color a little less bright, and to see if there is the right proportion of oil. If so, apply to the object, taking care, in shading, to take up but very little powder on the brush.

In putting on varnish, be careful to apply it evenly and not too heavily; if there is too much varnish in certain places, these will not take the bronzing as well.

The glazing of the bronzed articles—or the coating with a spirit lacquer—is done with an otter's hair brush, first warming the objects if possible. Rub the lacquer off the brush a little after each dipping; do not go over the surfaces too quickly, and not many times over one spot. If bubbles form, they can be left, as they will disappear of themselves.

In shading, when the ground is to be dull, which looks well in many cases, touch only the raised portions with the brush when glazing.

It will be in the best interests of the bronzer to use only the best, tested copal lacquer. Good lacquer will be ready to take bronzing in eight or ten minutes after its application.

The leather, so called, used for polishing, is sheep-skin or deer skin, chamois-dressed, that is, impregnated with oil.

In regard to the choice of colors, we have at our disposal the various bronzing powders, such as copper bronze, brass bronze, silver bronze (tin-gray), mosaic gold—aurum musivum—and antimony gray; these either alone or mixed with graphite, blood-stone, chrome yellow, Prussian blue, copper carbonate, verdigris, umber, cinnabar, zinc oxide, lamp-black, ultramarine (green or blue), chromic oxide, mineral colors, etc., as well as colored lacquers and varnishes. With the aid of the last beautiful varieties of color can often be obtained. But lacquers colored with aniline dyes will fade in the light.

The principal binding agents are linseed oil varnish, spirit varnishes, Dammar varnish, copal and amber varnishes, and different resin solutions; further, solutions of gutta percha in chloroform, benzol, or carbonic disulphide, solutions of wax or paraffine, asphalt varnish, sodium silicate solution, and solutions of celluloid (zapon varnish), as well as others.

TELEPHONE WHISTLE ALARM.

By R. O. WARREN.

ONE thing that cannot be heard in the average power plant is the telephone bell and, as a result, engineers have designed various apparatus for signaling their telephone calls. The general arrangement is to have a bank of five 110-volt lamps in series, with perhaps a red light to distinguish them from other lamps that might be in the station, but even this is not effective.

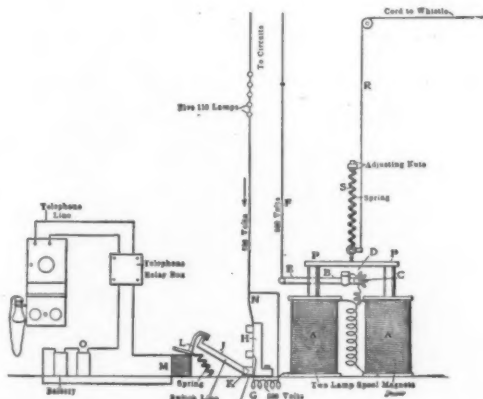
In the plant of the Charleston Street Railway and Power Company, Charleston, S. C., the chief engineer has arranged a whistle signal. Placed in a booth is a telephone of ordinary design, a telephone-relay box, a small magnet, which operates a switch automatically, two arc-lamp coils with their accompanying armature and a second switch. The general arrangement is shown in the accompanying illustration.

Above the lamp coils *A A* is a switch *B* which makes connection with a contact *D*. The blade of the switch has a pin at *C*, and is pivoted at the end *E*. A wire connection carrying 500 volts is attached to *E*. When the switch is in contact, as shown, the current passes out through the wire *F* from the switch *B* and coils *A A*.

Placed at a convenient point is a switch *H*, having two contact pieces, the knife blade *J* being pivoted at *K*, and held in an open position by the small catch arm and spring attached to the armature *L* of the magnet *M*. The lower terminal of the switch *H* is connected to the wire *G*, while the upper terminal is connected to wire *N*. The current passing through the coil *M* is obtained from the batteries *O*, the wires from which also pass to the relay box.

The operation is as follows: When a telephone call rings in, current from the batteries passes through the magnet *M*, which draws the armature *L* down and releases the catch from the end of the lever *J*, which is thrown into contact with the switch terminals by a coil spring placed on the pin at *K*. This sends a cur-

rent of 500 volts through five 110-volt lamps, connected in series, and at the same time allows current to pass around the coils *A A*, which draws the armature of that set of coils down with a sudden movement and in so doing the handle *C* of the switch *B* is brought in contact with the armature *P*, which throws the switch out of contact with *D*. This breaks



WIRING OF WHISTLE ALARM SYSTEM.

the circuit through *A A*, although the lamps still continue to burn.

In its downward movement the armature *P* draws down the cord *R*, which is fastened to the lever of a whistle, and blows the whistle twice. This double blow is obtained from the amount of slack in the cord *R*, and the action of the spring *S*, which causes the armature *D* to return to its original position after being drawn downward by the current passing through the coils *A A*. When the call has been answered the switch *J* is thrown out of contact and held open by the arm *L* and the switch *B* is thrown

into contact and held in place by the friction of the contact piece.

The effectiveness of this alarm was demonstrated while the engineer and the writer were out at the coal pile discussing the merits of various kinds of coal, the whistle alarm being distinctly heard above the noises of the plant.—Power and the Engineer.

THE COMO ELECTRIC SYSTEM.

THE region of Lake Como, which includes the north of Italy and the southern part of Switzerland, is already one of the principal centers on the continent for electric railroad lines. In addition to the already extensive system, there has been lately constructed an electric line which runs from Bellinzona to Mesocco through the Calanca valley in the Granbünden canton of Switzerland. The country traversed by this line forms a much-frequented route for traffic between Switzerland and Italy since early times, but the traffic fell off considerably after the St. Gotthard tunnel route was opened. Now that the electric line is built, there will no doubt be a considerable number of tourists to take it and besides it will facilitate the transportation of timber and agricultural products. The terminal station at Bellinzona will be used for exchanges with the St. Gotthard line, as it is situated within a mile of the latter. There is, however, no connecting line between the two railroads, on account of the great expense which this would have entailed. The new railroad is about 20 miles long and has a narrow gauge of 1 meter. Current is supplied to an overhead trolley line at 1,500 volts, and the trains are made up of motor cars and others on the "multiple unit" system. No difficulty is given by the profile of the road, as it is but 0.96 foot per mile, and the least radius is 260 feet. Current is supplied over a power line from the Cebbia hydraulic plant, and is transformed in the substation of Roveredo. The trolley line receives 1,500 volts direct current from this plant. The motor cars have 34 tons weight, and are provided with an electric heating system.

POWERFUL LIGHT MOTORS FOR AEROPLANES.

NEW WOLSELEY ENGINES.

BY H. J. SHEPSTONE.

THE reason generally given for the rapid advance of aerial navigation in France is that the French engineer has devoted much time and study to the construction of light and powerful motors, and that it is only possible to produce such machines in that country. There is, of course, much truth in this statement, but both the British and American engineer have now awakened to the undoubted market for powerful but light motors suitable for aerial craft.

The Wolseley Tool and Motor Car Company, Ltd., of Birmingham, England, has recently devised two light and powerful engines for aeroplanes, of 30 and 60 horse-power, respectively. The former has been entered for the Alexander competition for aeroplane engines, the object of which is to test their reliability.

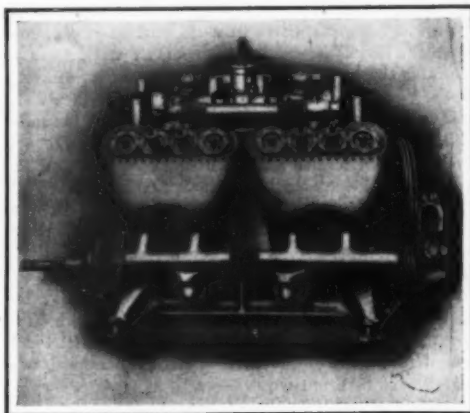
The weight of this engine, which is a four-cylinder one, is 205 pounds, complete with magneto, water pipes, and exhaust pipe, though it does not possess a flywheel. It is of the internal-combustion type, the cylinders being of 3¼-inch bore by 5½-inch stroke, developing 30 brake horse-power at 1,000 revolutions per minute, and 37 horse-power at 1,400 revolutions per minute. The cylinders are mounted on an aluminium crankcase.

All the valves are placed underneath on the same side of the motor, and are operated from the camshaft by hardened steel tappets. The carburetor is fitted with induction pipes, so arranged as to insure an equal distribution to the cylinders. The cooling is effected by a thermo syphon, and the ignition is on the Bosch high-tension magneto system. The cylinders are made of close-grained cast iron, the crankshaft of a high-grade steel, the connecting rods of the same material but with phosphor-bronze ends. The engine was tested at the works for three hours at "full load" and was found in every way satisfactory.

The other aeroplane engine is known as the "Vee" type. Strictly speaking, there are two engines, one for coupling the propeller direct to the end of the crankshaft, and the other arranged for driving the propeller at half speed by means of inclosed reduction gearing. The former, with all accessories, including magneto, plugs, wiring, water pump, oil pump, air pump, and exhaust pipes, weighs empty 350 pounds, and the latter, with of course all accessories, 365 pounds, also when empty.

The engine is of the internal-combustion type, possesses eight cylinders, each of 3¼-inch bore by 5½-inch stroke. The valves are also placed underneath the engine and on the inside, and are operated from a central camshaft by means of plungers. The camshaft is operated by steel gears driven off the crank-

The cooling is effected by water circulated by a gear-driven positive pump, while a similar arrangement insures perfect lubrication. The ignition is a self-contained eight-cylinder Bosch dual magneto with starting switch and is timed by a hand control. The material used is the same as that for the smaller



SIXTY HORSE-POWER WOLSELEY AERO ENGINE. VEE TYPE.

engine. At a recent bench test of three hours' duration it was shown that the engine could develop continuously 60 brake horse-power when running at 1,200 revolutions per minute, with a maximum of 75 brake horse-power for a short period at a higher speed.

NEW METHODS FOR GENERATING HYDROGEN FOR BALLOONS.

INVENTORS on the Continent have been occupied with the question of producing hydrogen cheaply for balloons. Among the most recent, we mention two different processes which are now used in Germany and Holland. At the Offenbach establishment, the following method is employed. If we cause water vapor to act upon carbon at a temperature which is below that necessary for forming carbon monoxide but sufficient for producing the decomposition of water vapor, we can obtain a gaseous mixture which is free from carbon monoxide and in consequence is richer in hydrogen than water gas. It is therefore necessary to modify the process for obtaining water gas. Charcoal is to be used for the carbon, and it is impregnated with

this preparation, and the temperature should not exceed 650 degrees at the bottom and 450 degrees at the top. Water vapor heated at 400 degrees is introduced at the bottom of the retort. The gases coming out of the retort are sent into a scrubber, where the dust is taken up, and then pass into a soda absorbing column in which the carbonic anhydride is absorbed.

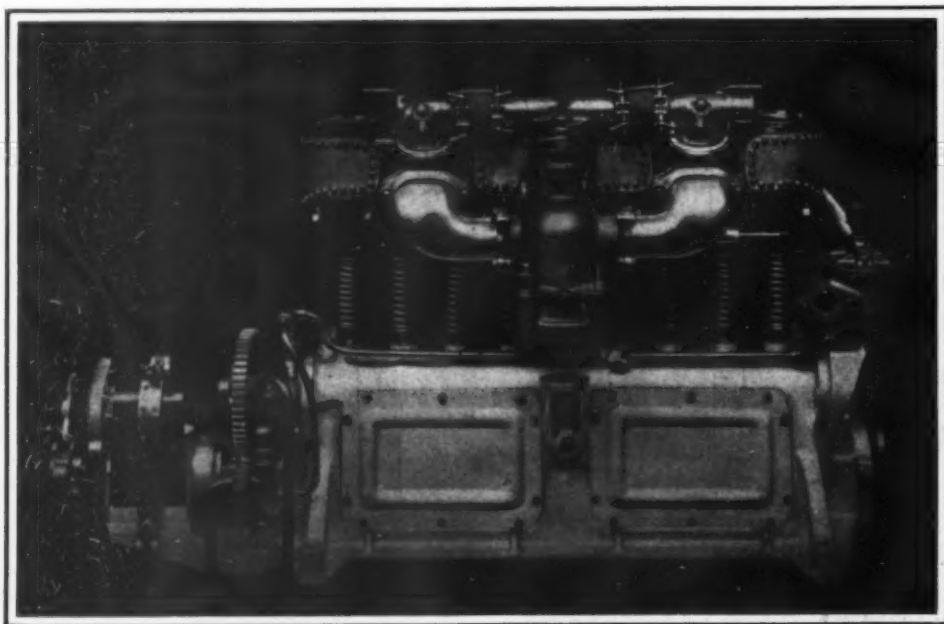
An automatic feeding device for the carbon and lime mixture placed at the top of the retort allows of a continuous working of the apparatus. The average composition of the gas which is thus obtained is: Hydrogen 99.50 per cent, carbon monoxide 0.30, carbonic anhydride 0.08, divers 0.12. The ascensional force of this mixture is 1,180 grammes per cubic meter (1.98 pounds per cubic yard), and the cost of manufacture is 15 to 18 centimes per cubic meter (\$0.024 to \$0.03 per cubic yard). This cost will be still lower if coke is used instead of the wood charcoal, and experiments which are now being carried on show that this can likely be done in the future.

The second process which we wish to note is the Rinker-Wolter, and it has been experimented upon at Utrecht. It consists in decomposing liquid hydrocarbons by carbon at a high temperature. In this way we obtain a mixture of gas which has a variable composition according to the temperature at which the dissociation is effected. The hydrocarbons used here are the residues of petroleum or coal-tar distillation, or tar coming from water gas manufacture. The present process is the subject of experiments made at the municipal gas plant of Utrecht, which manufactures coal gas and also water gas for the city supply. The hydrocarbons used in the new process are sprayed at the top of the incandescent coke columns. According as we make the decomposition at low or high temperatures, we obtain a gaseous mixture having a lighting power about like that of illuminating gas, or on the other hand a mixture having the following composition: Hydrogen 96 per cent, carbon monoxide 2, oxygen, nitrogen and carbonic anhydride, 2 per cent. The greater part of the carbonic anhydride is eliminated by passing the outgoing gas through a soda absorber. The specific gravity of the mixture lies very near that of hydrogen, so that it is quite suitable for filling balloons. In the experiments at Utrecht, the raw material consists of a mixture of gas oil and tar coming from water gas manufacture. The price in this country is 6 centimes per cubic meter (\$0.01 per cubic yard). The inventors of the process are now engaged upon plans for a portable gas plant, and this is to be mounted on a type of vehicle of which the German army has ordered a certain number.

On an analogous principle to the above, M. Oechelhauser used a process in his gas works at Dessau, Germany, and he produces a gaseous mixture containing 80 per cent hydrogen with small quantities of methane, carbon monoxide and nitrogen. He passes illuminating gas through an incandescent coke column, thus working at a temperature of 1,400 deg. C.

We note that the new hydraulic plant located at the falls of Trohätten, Sweden, will soon be opened for service. It will be remembered that this is one of the largest turbine plants in Europe, and will produce current to the extent of 80,000 horse-power. The station will furnish current to Goeteborg and other cities in the southern part of Sweden, but longer lines will also be run. It is planned to supply Copenhagen and a part of the island of Zealand, and to carry this out a land line will run from the central plant as far as Helsingborg, Sweden. On the other hand, an electric line will be installed from Helsingborg, Denmark, to Copenhagen. These two land lines are then to be connected by a submarine cable of about three miles in length which will be laid in the Oeresund. In this way it will be possible to supply 50,000 horse-power upon Danish territory. Estimates are now being made as to whether current delivered by the above power line will be cheaper than what can be produced in Denmark by a steam plant located at Copenhagen, and upon this will depend the feasibility of the project.

A consular report dealing with the trade of New Orleans during the year 1909 states that the Southwest Pass is to be lighted by eight gas buoys, and a combined light and whistling buoy is to be placed on the Trinity shoal in Louisiana. These buoys are 25 feet long, the center of the light being 13 feet 6 inches above the surface of the water. Charged with Pintsch gas, these lights, with a 10-second flash burner, will burn for three months without re-filling.



THIRTY HORSE-POWER WOLSELEY INTERNAL-COMBUSTION AERONAUTIC MOTOR.

shaft—the gears and camshaft being totally inclosed. The carburetor is of the float feed and spray type with annular float and is mounted in the center of the engine directly over the camshaft. This arrangement allows of short induction pipes, and insures an equal distribution to the cylinders.

silicate and carbonate of potassium. This is done by dipping it for a certain time in a solution of these two salts and then allowing it to dry. The result of this operation is mixed with broken up lime and fed into a vertical gas retort which is heated by gas from a producer. The proper heating is the main point in

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TREASURE RECOVERY FROM THE DEEP.*

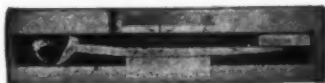
EXPLOITS OF THE DIVER.

The treasure seeker's operations, whether on land or under sea, are usually surrounded with a halo of romance, and without doubt the branch of submarine work which appeals most to the popular imagination.



Group of water vessels, one with sponge adhering to it, recovered by divers from a submerged island in the Greek archipelago.

ation is that which is concerned with the recovery of treasure from the deep. Great was the excitement when the chief of the expedition sent out to recover the treasure which went down in the "Alphonso XII," in 160 feet of water off Point Gando, Grand Canary,



Officer's sword from the French man-of-war "L'Orient," admiral's flagship, which blew up during the fight with Nelson's ships at the battle of the Nile, August 1, 1798; recovered by a diver in 1890.

cabled home: "Lambert has got both scuttles open, and got into the magazines. The boxes of gold are there." £90,000 in coin of the Spanish realm, which before the advent of modern diving appliances would have been irrecoverably lost!



One of the seven treasure chests, each containing Spanish gold coin to the value of £10,000 sterling = £70,000 in all, recovered from the wreck of the Spanish mail steamer "Alphonso XII," sunk off Point Gando, Grand Canary, in the great depth of 27 fathoms = 162 feet. One of the actual gold coins is set in a glass panel fixed outside the chest.

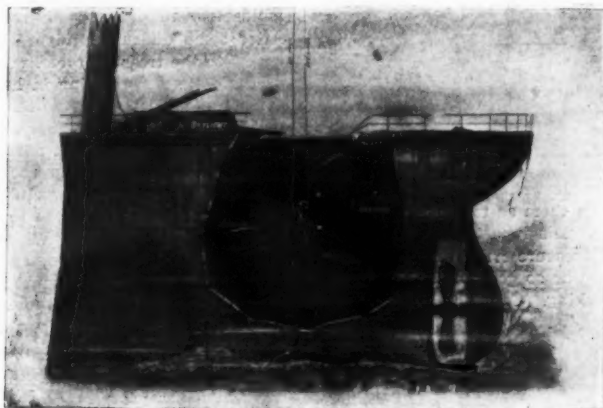
It was Lambert, too, who saved the situation when the Severn Tunnel was flooded some years ago. A certain door in the drainage tunnel (8 feet by 8 feet) had been inadvertently left open. The door was situated about a quarter of a mile from the shaft, in which the

* From a diving manual published by Messrs. Siebe, Gorman & Co., Ltd., Submarine Engineers, London.



Ancient Greek lamp, with sponge grown to the oil reservoir, found by a Greek sponge diver in 140 feet of water off Syria. The lamp is of bronze, and dates 800 years B. C.

water had risen about 40 feet. Equipped in his diving dress, the brave fellow crept through the narrow passage, full of water and floating debris, and succeeded in closing the door. This daring act enabled



Diver Alexander Lambert forcing his way to the treasure room of the S.S. "Alphonso XII," from which he recovered seven chests containing £70,000 in gold coin. Another diver recovered £20,000.

the pumps to overcome the volume of water, and the work of completing the tunnel proceeded.

Another notable case was the salvage of about £10,000 worth of silver bars from the wreck of the steam-

about two miles off the coast. An expedition went out in the same year (1891), but was unable to secure the treasure, and in 1895 Mr. J. K. Moffat, of Bilbao, entered into negotiations with Lloyd's underwriters,

and spent some time in further operations, which had to be suspended owing to bad weather setting in. In 1896 another effort was made with more powerful diving apparatus, and resulted in fifty-nine bars being



Hunting knife, set with diamonds, valued at £7,000, recovered from the "Cadiz," wrecked between Ushant and Molène, on the French coast, at a depth of 15 fathoms.

ship "Skyro." This vessel sailed from Cartagena for London with a valuable cargo, including bar silver. Approaching Cape Finisterre in foggy weather, the vessel struck on the Mexiddo Reef, but passed over and went down in deep water within twenty minutes,



These two pictures are of relics recovered during diving operations in Tobermory Bay, Scotland, in connection with the location of the galleon "Florescia," the flagship of the Florentine squadron, which was sent to assist the Spanish Armada in A. D. 1588, and which was blown up and sunk one night by the Highland chief Donald Glas McLean, who was held captive on board. The "Florescia," which was built of African oak, and carried 56 guns and a crew of 486, had on board bullion and other treasure of the estimated value of two millions sterling. On board were also a number of priests, and among the treasure was a considerable quantity of valuable church ornaments, etc.

recovered. The working depth of the diver was never less than 28½ fathoms, or 171 feet, and it frequently exceeded this. To obtain these bars it was found necessary to blow away the deck with dynamite, which the diver—A. Erostarbe—did only after great difficulty, owing to the boisterous state of the weather. Work had to be suspended in October, but was again



Vase, with relics made from portions of the timber and guns of H.M.S. "Royal George," flagship of Admiral Kempenfeldt, sunk at Spithead in 1782, over 800 lives being lost. A group of relics from the "Royal George," the salvage operations on which extended over six summers (1839-1844): Silver dish from Admiral Kempenfeldt's cabin. Silver spoon from Admiral Kempenfeldt's cabin. Clay pipe. Silver shoe buckle. Portions of sword from Admiral Kempenfeldt's cabin. Wine bottle with oyster shells adhering to it. Silk neckerchief. Old pistol. A seaman's thigh bone. Sole of a shoe, with remains of a candle. China cup. Small shot. Copper rivets and a medal. An officer's ring taken from his remains. Narrative of the loss of the "Royal George," bound in two pieces of the wood of the vessel.

resumed in 1897, with the result above reported. When one takes into consideration the wild and exposed position of the wreck, which lies about nine miles south from Cape Finisterre, the strong currents that prevail in the locality, the rough weather that had to be contended with, the fact that the diver had to use dynamite to effect an entrance into the cabin where the silver bars were stowed, and that the deck was collapsed to within 18 inches of the cabin floor, on the

starboard side of the silver, some idea of the danger our nature of the undertaking may be realized. The diver reported that when he had finished there was no part of the wreck, fore and aft, standing higher than himself, excepting the engines and main boilers; it was just a heap of old iron. To Diver Angel Erostarbe was due the greatest praise for the indomitable pluck he displayed in carrying out this most difficult submarine undertaking.

The ship "Hamilla Mitchell" was lost on the Leu-



Wheel of a pulley block recovered from the "Mary Rose," sunk in the reign of Henry VIII., after being under water 295 years.

onna Rock, near Shanghai, having a heavy cargo in addition to specie valued at £50,000. Lloyd's agent was instructed by the underwriters to visit the scene of the wreck, and inform them as to the feasibility of recovering the treasure. His report was that he considered the cargo and treasure irrecoverably lost, as the depth of the water was so great and the position too dangerous for working. Capt. Lodge, however, undertook the task, and having consulted Siebe, Gorman & Co. as to the diving gear he should require, they supplied him with a set of their apparatus specially constructed for deep sea diving; and having en-

gaged two experienced divers, Messrs. R. Ridyard and W. Penk, of Liverpool, Capt. Lodge left England and duly arrived at Shanghai, where he engaged the pilot cutter "Maggie," and proceeded in search of the wreck. This operation had to be prosecuted by means of a boat, as the larger vessel could not proceed so close to the high rocks. After a search in different depths, varying from 120 feet to 160 feet of water, the divers at length found the wreck. The after part containing the treasure had rolled into deep water, 26 fathoms or thereabout, for it appears that when the "Hamilla Mitchell" struck the rock, she rested on a ledge, but subsequently gales caused her to part amidships, the after part rolling into deep water. After some difficulty Ridyard succeeded in obtaining access to the treasure room, where he found that some of the dollars were lying in heaps, the worms having eaten the wooden boxes so that they were completely riddled. Ridyard made four successful trips, the last of which proved the most advantageous of all, for on that occasion he sent up the contents of sixty-four boxes of treasure. Ridyard being thirsty, W. Penk volunteered to ascend to the top of the island to fetch him some spring water. While filling the bucket he looked round the horizon, and to his astonishment he saw an innumerable quantity of white sails coming from the mainland. He informed Capt. Lodge of the circumstances; that gentleman identified them as several hundred piratical junks bearing down upon the island. Orders were therefore given to slip the anchor and chain, but the wind being light they were obliged

to make use of oars; and, although in an exhausted condition, Ridyard pulled some time until a breeze sprang up, when they were enabled to make sail, and with the aid of night they reached Shanghai safely, running a very close risk, not only of losing the treasure they had on board, but also their lives. The Shanghai papers blame the authorities for not giving the expedition sufficient protection. The total amount of treasure recovered was £40,000, and but for this *contretemps*, Ridyard would have completed the



Carpenter's plane, found in the wreck of one of the vessels of the Spanish Armada, sunk in Vigo Bay. The difference between the handle and the position of the planing iron of this plane and of the present-day plane will be apparent.

entire salvage of the treasure. The balance was recovered some time later.

These three operations are particularly notable by reason of the great depths from which the specie was recovered, but much larger sums in specie, etc., have been recovered from vessels sunk in shallower depths, as, for instance, in the cases of the "Malabar," from which bullion to the value of £300,000 was saved; the "Darling Downs," cargo of wool, etc., valued at £100,000 (of 725 bales all but five were recovered by divers); steamship "Queen Elizabeth," cargo and specie valued at £120,000.

MARS DURING THE RECENT OPPOSITION.

AN UNEVENTFUL ASTRONOMICAL EVENT.

BY W. E. ROLSTON.

SO FAR AS can be judged from those yet published, the results accruing from the observations of Mars made during the opposition of 1909 are, says Nature, in a sense, disappointing. The favorable conditions of the opposition, as regards the altitude and the apparent diameter of the planet, engendered the hope, in many minds, that most of the outstanding problems in the Martian enigma would be solved more or less definitely. Yet the camps into which aerographers are divided are still at issue, and the differences appear to be at least as sharply accentuated as before. To the one side the *canali* are still continuous channels, set out with a rectitude more or less geometrical, and having "oases" around the reservoirs upon which they appear to converge; but to the opposition these clearly cut channels are but alignments of dark spots merged into apparent continuity by a physiological illusion.

However, many of the larger features are beyond dispute, and many valuable observations of their appearances and changes have been made since July last. One very remarkable phenomenon was noted, and has been discussed by practically every observer, viz., the apparent veiling of the planet's surface during the earlier part of the opposition.

In June, July, and August the details, and even some of the larger features, were not discernible; there was a general lack of contrast between the light and the dark areas. Thus M. Antoniadi, using the 24-centimeter (9.45-inch) refractor at Juvay, reported (Bull. de la Soc. astron. de France, September, 1909, p. 386) that, on August 11th and 12th, the surface of Mars was hardly recognizable, and it was with great difficulty that he assured himself that it was the region of the Mer de Sablier on which he was looking. M. Jarry Desloges also emphasized the unusual appearance of the planet, which he illustrated (Comptes Rendus, vol. cxlix., No. 17, p. 666) by two charts, on one of which M. Fournier had recorded the features seen during June, July, and part of August, while the other showed the increased contrast of the same features later in August and during September.

It was not until the beginning of the last month that the accustomed contrasts and details completely reasserted themselves and permitted the work of confirmation and discovery to proceed normally.

M. Antoniadi suggests that this masking effect was caused by the interposition of light, cirrus cloud in the planet's atmosphere, such cloud being filmy in structure and yellowish in color, so that it reduced the usual contrasts without totally obscuring the features. This is in accordance with Prof. W. H. Pickering's observations in 1895, when he found that his photographs suggested some such yellow screen.

The importance of the acknowledged existence of clouds must not be lost sight of in the discussion as to the aqueous contents of the planetary atmosphere.

The observations of Beer and Mädler, Secchi, Lockyer, Denning, and others, of apparent changes caused by clouds have been generally accepted as strong evidence for the existence of the cloud-producing compound of our own atmosphere.

Turning now to the actual observations of features, and their modifications, during the recent opposition, we find that the diminution and transfiguration of the southern polar cap was recognized quite early in the season.

M. Jarry Desloges, observing with a 29-centimeter (11.41-inch) refractor at Masegros (Lozère), recorded (Astronomische Nachrichten, No. 4340) a dark cutting in longitude 190 deg. on June 20th-23rd, and at the Revard station Lowell's crevasse in longitude 350 deg. was easily seen, cutting right through the cap. A large and brilliant spot near the edge of the cap, in longitude 30 deg., was also seen on July 4th. The progressive diminution in size and the changes in the southern polar cap of Mars, were observed by M. G. Fournier at the Revard Observatory, and M. Desloges (Comptes Rendus, No. 26, vol. cxlix., p. 1347), remarks on the increased rate of diminution about August 15th, and suggests that the variations in detail and the time of disappearance are probably indications of inequalities in the relief of the polar areas.

M. R. Jonckheere, observing with a 14-inch refractor at the Hem Observatory (Roubaix), also directs attention to this feature. On August 12th he observed (Astronomische Nachrichten, No. 4354, p. 159) a "land" become detached from the cap, although itself still covered with ice, and identified it as Schiaparelli's Novissima Thyle. On these grounds he suggests (Comptes Rendus, No. 22, vol. cxlix., p. 970) that the "lands" remain covered with ice much longer than do the "seas," thus producing apparently irregular variations in the measured diameters of the cap; when, by the planet's rotation, such an ice-covered "land" is brought to the extremity of the apparent ellipse, the major axis will appear to be longer than when the "land" is carried further round. M. Jonckheere's measures of the cap show the following progression: July 16th, 32 deg. (Martian arc); August 15th, 18 deg.; September 17th, 9.3 deg.; October 18th, 11.8 deg.; November 18th, 10.2 deg. On September 2nd, Argire II. was seen, and its position determined as longitude 60 deg., latitude -40 deg.; this is nearer the pole than it has hitherto been placed, and M. Jonckheere deduces, generally, that the latitudes ascribed to the polar lands are usually too small. Another mass was seen, on the same evening, in longitude 120 deg., latitude -84 deg., which apparently had not been recorded before, and to this M. Jonckheere gives the name "Stella," on account of its brightness. "Thaumas" is the name given to another new land which suddenly appeared in the Aonius Sinus, touching Thaumasia, longitude 100 deg., latitude -43 deg.

According to Prof. Lowell (Astronomische Nachrichten, No. 4371, p. 47), the first snowfall of the season in the Martian antarctic region took place on November 17th—about two months after the summer solstice—when two patches in latitude -65 deg. were seen in longitudes 100 deg. and 190 deg.

M. Antoniadi also made observations, at the invitation of M. Deslandres, with the 33-inch refractor of the Meudon Observatory, the third largest refractor in general use. He observed on thirty nights between September 20th and November 9th, but on about five nights only were the atmospheric conditions really good. The most noticeable change since 1907 was in the Syrtis Major, which he found had returned to its form of 1864 and 1877. The Lac Meris, too, had reappeared as a large, indefinite dark patch, and a multiple island was seen in the eastern part of the Mare Cimmerium.

The Solis Lacus region also presented many striking features, and, among others, M. J. Comas Sola devoted special attention to it (Bull. de la Soc. astron. de France, November, 1909, p. 497). In his opinion, the recent opposition "peut être considérée comme la dernière définitive du réseau géométrique des canaux."

It is in regard to these all-important "canals" that the battle of observers rages most intensely. Among European observers, at least, there appears to be consensus of opinion that the term should be used in a more restricted sense, or should only be employed as a generic term embracing several species. There is too great a diversity between the broad, persistent, half-tone patches and the narrow, evanescent streaks, glimpsed for one fraction of a second to be lost the next, for them all to be grouped under the one designation. M. Antoniadi strongly insists on this point (Comptes Rendus, vol. cxlix., No. 20, p. 836), and classifies eight varieties. Even then he does not include the fugitive right lines, visible only for the fraction of a second, which he considers may be illusions; but he very definitely negatives the existence of any geometrical *réseaux*, of which he finds no trace. At intervals of exceptionally good seeing he sees considerable structure, visible for several consecutive seconds, on the continental areas, and this he describes as "a gray irregular marbling, complex and cloudy, such as only an artist could render."

The Rev. T. E. R. Phillips, observing at Ashted with his 12-inch Calver reflector, was led to substantially the same conclusions (the Observatory, No. 416, p. 463) as M. Antoniadi regarding the canals.

The necessity for the classification of these features is also advanced by M. Desloges, who suggests (Comptes Rendus, vol. cxlix., No. 17, p. 664) three species, and also directs attention to numerous changes observed during this opposition. The fine *canaux* of his third class were apparently the most affected by the seasonal changes, and M. Desloges finds it difficult to disbelieve their objective existence; one

argument advanced in its favor is that they all appear to start in small gulfs, just as the broad, indubitable, dark bands, of the first and second classes, generally have their origins in the larger gulfs.

An encouraging feature of the opposition, which in future developments may lead to a settlement of this vexed question of "objective" and "subjective" phenomena, is the advance made by photography in the recording of the planet's markings. On Prof. Hale's striking photographs (Monthly Notices, vol. lxx., No. 2, p. 175) the contrast between the dark and light areas is remarkable, the bolder features standing out with a distinctness usually seen only on carefully prepared drawings.

Results of great interests were also obtained by MM. de la Baume Pulvinel and Baldet (Comptes Rendus, vol. cxlix., No. 20, p. 838) at the Pic du Midi Observatory, where the conditions are especially favorable for such observations. The observers intend to make a detailed study of the 1,350 images recorded on their set of eighty plates, but, from a brief survey, they are able to state that anyone conversant with Martian topography would immediately recognize nearly all the features observed visually. The canals of the first order, the broader bands such as the Indus, the Ganges, Araxes, Cyclops, Euphrates, etc., are all recognizable, but there is no trace of the geometrical network of fine canals recorded visually by many observers.

While in London recently, Prof. Lowell pointed out that while many of the recent photographs form striking pictures by reason of their strong contrasts in the large areas, the treatment which brings out these contrasts is not that calculated to show also the finer details.

Thus the evidence for the actual existence of the canaliform "canals" is still "mixed." A number of experienced, careful observers still proclaim, with no lack of decision, that they exist; others just as emphatically state that they are, at the most, but the physiological integration of the elements of a mosaic groundwork which covers the planet. Prof. Frost states that the 40-inch refractor at Yerkes is "too powerful" to show them, and Prof. Hale refers to Prof. Barnard's description of 1894 (Monthly Notices, vol. lvi., No. 4, p. 166, 1896) as describing exactly what he sees with the 60-inch reflector at Mount Wilson.

This question of aperture is not a simple one. Thus Prof. Lowell has repeatedly stated that a large aperture is not infrequently a positive barrier to the seeing of such fine details as occur on planetary disks. Attached to his 24-inch refractor he has a system of diaphragms, and the first operation in making an observation is to determine what aperture is most suitable for the conditions obtaining at the moment. A similar procedure was followed by Dawes, whose observations in the sixties of last century did so much to forward aerography. When discussing the work with Sir Norman Lockyer—who also, at that time, was making valuable drawings of Mars—Dawes repeatedly referred to the conditions of seeing as "a 5-inch night" or "a 6-inch night," etc. Asked for an explanation, he stated that he often found it necessary to reduce his aperture, which normally was 8 inches.

We also learn from Sir Norman that when his drawings were discussed at the Royal Astronomical Society, some doubt was expressed because some of the details shown thereon were not shown on the drawings made at the same epoch by the observer using Lord Rosse's reflector; yet when the Leyden

drawings arrived, later, these details were confirmed.

Thus Prof. Frost's somewhat enigmatical statement may, logically, be understood to convey a meaning other than that which has generally been ascribed to it, and the failure of the 60-inch reflector to show the straight, hard, sharp lines may not be conclusive evidence of their non-existence.

So far, the employment of the photographic plate has not provided the hoped-for solution of this special question, because the exposures necessary are too long. Each image on the plate is an integration, the moments of fine seeing are overlaid by periods of tremor, and, by their very nature, fine lines would be the first to disappear; it is a case where negative evidence is of little value. Nor does it seem logical to say that these lines do not exist because their appearance can be explained otherwise—physiologically, for instance. Their recognition in the same positions by independent observers, at different times, points to the existence of some material objects, and their changes with the change of season exclude the proposition that they are completely solid markings. Even the suggestion that they are alignments of darker spots does not prove that they are disconnected items. In desert areas the streams dry up, leaving "water holes"—apparently disconnected if viewed from a great distance—and these holes are surrounded by vegetation throughout the dry season, becoming, therefore, isolated objects; but the river bed is there, and in due season—as on Mars—is filled with water and edged by vegetation.

But their great size, their prolific distribution, and their rectilinear character, even when seen away from the planet's central meridian, are phenomena which are difficult to explain in the case of the Martian canals; and the problem yet remains.

A suggestion made by Dr. Aitken, of the Lick Observatory, might possibly solve this vexed question to some extent. Prof. Lowell's unanswerable argument is that, as the "canals" are so near the limit of vision, it is only in the very finest atmosphere that they can be seen. All observers agree as to the first part of this statement, and Dr. Aitken suggests that the second part might be put to the test by arranging that such experienced protagonists as Prof. W. H. Pickering, M. Antoniadi, and Prof. Barnard should foregather at the Flagstaff Observatory and, with Prof. Lowell, observe Mars during the next favorable opposition. The 24-inch refractor is, as Prof. Lowell has demonstrated, a superb instrument, and for astronomical observations of this character the Arizona atmospheric conditions are unexcelled. The suggestion is a most excellent one, and, could the arrangements be made, the meeting would no doubt lead to an illumination of what, at present, is a very obscure problem.

There are some problems in astronomy which seem to be indeterminate. First, we get a positive solution in one direction, and then appears the amendment, which is a direct negative; as an example one might cite the rotation periods of the inner planets; but one that is nearer to the present question is the problem as to the spectroscopic evidence for the existence of water vapor in Mars.

Since Huggins compared the Martian and the lunar spectra in 1867, a number of observers have made similar observations under various conditions, and with contradictory results. The summarized history of the research is given by Prof. Campbell in a recent bulletin (No. 169) from the Lick Observatory, and the majority of the conclusions are in favor of the presence of water-vapor bands; whether the conclusions

were supported by the evidence, when adequately analyzed, is the question. Observations made at Mount Hamilton in 1894 demonstrated to him that, to obtain satisfactory evidence, they should be repeated at an altitude sufficient to escape the greatest possible proportion of the terrestrial atmospheric effects, and, to this end, he examined the conditions obtaining on the summit of Mount Whitney, the highest point in the United States, in 1908. The preliminary survey satisfied Prof. Campbell as to the atmospheric conditions, and he decided that, if the necessary money could be obtained for shelters and equipment, an expedition from the Lick Observatory should take advantage of the favorable opposition of 1909 to carry the research a step further. As is usual in, and, one might say, peculiar to, America, funds were forthcoming, with the result that, at the end of August, 1909, the summit of the mountain was occupied by an expedition ready to take spectrograms when the conditions of Mars and the moon were favorable.

Such spectrograms, six in number, were secured on the nights of September 1st and 2nd, and it is to the discussion of the evidence afforded by these that Bulletin No. 169 is devoted. This evidence does not appear to be positively conclusive, but Prof. Campbell deduces "that the quantity of any water vapor existing in the equatorial atmosphere of Mars at the time these observations were made was too slight to be detected by present spectrographic methods. . . . It is difficult to conceive that the quantity of vapor above unit area on Mars could exceed or equal the quantity of terrestrial vapor above the same area of Mount Whitney."

It should be remarked here that the altitude of the summit of Mount Whitney is 14,501 feet, and, according to Hann's empirical formula, 0.79 of the terrestrial water vapor would be below.

Prof. Campbell expressly states that it is not contended that Mars has no water vapor, and that polar caps composed of hoar-frost, demanding a small quantity of vapor, would probably not be out of harmony with his observations. In Bulletin No. 43 of the Lowell Observatory Mr. Abbot's report is quoted to the effect that he and Prof. Campbell were on Mount Whitney during unusually unfavorable weather, under conditions which would probably not be met with at that season one year in ten. This is important, because, no matter how much of the theoretical water-vapor content of the terrestrial atmosphere was left below, it is absolute evidence that water vapor was present, in quantity, above.

The Mount Whitney plates, at the most, only afford negative evidence, and it is not contended that they do more. Thus the question of water vapor becomes one of amount rather than of existence or non-existence, and its settlement is rather academic than practical. There is no doubt as to the difficulty of securing absolute evidence—so many variables have to be eliminated before the sought-for residual is attained.

But, as stated above, the question is now generally accepted as settled in favor of the presence of water vapor in the Martian atmosphere. The darker edge of the melting "snow" caps, the proved existence of clouds, and the changes of intensity and shape of many features, point definitely to the existence of a fluid material, and, without any violent assumptions, to that fluid being water. We note that Prof. Campbell suggests that the observed yellowish color of the clouds may indicate for them some other chemical compound than H₂O, but, if this is so, should not the spectrum of Mars indicate some other absorption which is not mentioned?—Nature.

FIELD WORK IN BOTANY.

PROF. J. W. H. TRAIL, before the British Association for the Advancement of Science, spoke of work in the field, and said: "There are few paths more likely to prove attractive to most students. The study of the plants in their natural environments will lead to an understanding of their nature as living beings, of their relations to one another, and to other environments of the stimuli to which they respond, and of the struggle for existence that results in the survival of certain forms and the disappearance of others. In this way also will be gained a conception of the true meaning and place of classification as an indispensable instrument for accurate determination and record, and not as an end in itself. To one that has once gained a true insight into the pleasure and worth of such studies, collections made for the sake of mere possession or lists of species discovered in a locality will not suffice. Many questions will arise which will prove a constant source of new interest. From such studies a deep and growing love for botany has in not a few cases arisen." He urged the necessity of a complete survey of British botany. Much excellent work had already been accomplished and put on record toward the investigation of the flora, but much of that store of information was in danger of being overlooked and forgotten or lost owing to the absence of means to direct attention to where it might be found. A care-

ful revision of what had been done, and a systematic subject-index to its stores were urgently required. The systematic works treating of the flora were in great part not fully representative of the knowledge already possessed, and required to be brought up to date, or to be replaced by others. Great difficulty was caused by the absence of an authoritative synonymic list that would show as far as possible the equivalence of the names employed in the various manuals and lists. There was much reason to wish that uniformity in the use of names of species and varieties should be arrived at, and a representative committee might assist to that end; but, in the meantime, a good synonymic list would be a most helpful step toward relieving a very pressing obstacle to progress. There was need for a careful analysis of the flora with a view to determining those species that owed their presence here to man's aid, intentional or unconscious. The topographic distribution, though so much had been done in that field during the past sixty or seventy years, still required careful investigation. A careful study of the flora was also required from the standpoint of structure and development. While "English Botany" in its first edition was deservedly regarded as a work of the first rank among floras, it had long been defective as representing our present knowledge of British plants, and it had not been succeeded by any work of nearly equal rank, while other countries

now had their great floras of a type in advance of it. There was need for a great work worthy of our country, amply illustrated so as to show not only the habit of the species and varieties, but also the distinctive characters and the more important biological features of each. Such a flora would probably require to be in the form of monographs by specialists, issued as each could be prepared, but as part of a well-planned whole. It should give for each plant far more than was contained in even the best of our existing British floras. He believed that a well-organized botanical survey of the British Islands would give results of great scientific value, and that there was need for it. He believed, also, that means existed to permit of its being carried through. There was no ground to expect that it would be undertaken on the same terms as the Geological Survey. A biological survey must be accomplished by voluntary effort, with possibly some help toward meeting necessary expenses of equipment from funds which were available for assistance in scientific research. Was such a survey not an object fully in accord with the objects for which the British Association existed? In the belief that it was so he asked the Section to consider whether such a survey should not be undertaken; and, if it approved the proposal, he further asked that a committee be appointed to report on what steps should be taken toward organizing such a survey.

PRACTICE AND THEORY OF AVIATION.—V*

THE LEADING AEROPLANES

BY GROVER CLEVELAND LOENING, A.M.

Continued from Supplement No. 1819, Page 310.

PART B: COMPARISON OF THE SUCCESSFUL AEROPLANE TYPES.

IN comparing the successful types of aeroplanes, not only can several interesting contrasts and distinctions be drawn, but conclusions as to the future can be made. For this purpose the aeroplanes are compared according to the following essential features:

- I. Mounting.
- II. Rudders.
- III. Keels.
- IV. Transverse Control.
- V. Aspect Ratio.
- VI. Incident Angle.
- VII. Propellers.
- VIII. Efficiency.
- IX. Speed.
- X. Flight.

I. MOUNTING.

There are three distinct types of mounting:

- (a) Skids alone—Wright (1909).
- (b) Wheels alone—Curtiss, Voisin (both types), Blériot (both types), Pelterie, Grade, and Pitzner.
- (c) Skids and wheels combined—Farman, Antoinette, Santos Dumont, Cody, Sommer, and Wright (1910).

The necessity of providing springs on a heavy machine mounted on wheels has frequently been emphasized.¹ M. Blériot has called special attention to the fact that a high speed screw generates a gyroscopic force which tends to resist all vibration or sudden changes of its axis.² If, therefore, when running over the ground the machine be suddenly jarred, the propeller is likely to snap off. This has often been experienced by M. Blériot himself, and was only obviated by the use of a very springy mounting.

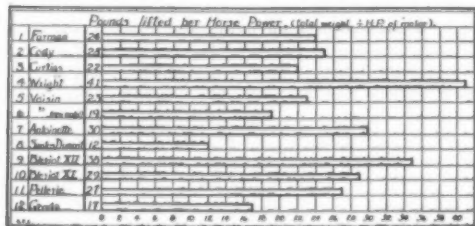


TABLE I. (a).

The relative merits and demerits of mounting on wheels or skids are subjects of wide discussion.³ The advantages of mounting such as in the Wright machine become very great when starting is to be made from soft soil or rough land, since the rail upon which the machine is placed can be laid down in almost any kind of country. Wheels, however, require a certain area of reasonably smooth and hard ground, a condition not always met with. A machine fitted with skids can withstand rougher landings, and upon alighting stop within a few feet. Furthermore, by using a rail, and, in addition, as is often done with Wright machines, a starting impulse given by a falling weight,⁴ a less powerful motor is needed for starting.

Nevertheless, the skid mounting has a great disadvantage in that a machine fitted with them, when once landed away from its starting rail, cannot again take to flight. This has caused skids alone to be dis-favored by many aviators. Several combinations of skids with wheels have been proposed and tried, and some of the recent Wright machines have had wheels fixed to the skids to enable a fresh start immediately after landing. These combinations, of which the mounting on the Farman and the Sommer are typical, work with great satisfaction and appear at present to be most desirable for a heavy machine.

On light aeroplanes such as the Curtiss and the Grade, where the loading is reasonably light, springy mountings have been found unnecessary.

It is likely, however, that the high speed aeroplane of the future will not only be provided with an elastic mounting, but will be projected from some ingenious starting device at high velocity so that it may be quickly launched into the air.

II. RUDDERS.

The direction rudder in all the types except the Pitzner is placed at the rear. The Cody biplane has an additional direction rudder in front. All the mono-

planes excepting the Pitzner have their elevation rudders at the rear, while in all biplanes, excepting the Voisin (tractor type), and the newest Wright and Voisin types, this rudder is placed out in front. Rudders placed at the rear are advantageous in that they act at the same time as keels.⁵ But, in general, the placing of the elevation rudder in front appears to offer more exact control of the longitudinal equilibrium.

The elevation rudder almost always exerts some supporting power. Therefore, when placed in front and turned up for ascent, the support is increased as it naturally should be. But when this rudder is placed at the rear the movement for ascent is such that the supporting power of the rudder is decreased and usually of negative value, so that instead of causing the front of the machine to rise, it merely causes the rear to sink.⁶ The same line of argument shows us that when starting, if the elevation rudder is out in front, the front of the machine lifts off the ground strongly and is followed by the body, while if this rudder be in the rear, when turned to give ascent, the rear merely sinks more, and not only is the length of run enormously increased, but the power absorbed and the danger incurred are greater. This is obviously a bad provision. That it is so generally used on monoplanes seems to be caused only by the placing of the propeller at the front.

In the Wright biplane the elevation rudder is so constructed that when elevated it is automatically warped concavely on the under side, and when depressed curved in the opposite way. This materially adds to the rudder's force due to the peculiar law of aerodynamics whereby a curved surface, under the same conditions as a flat surface, has a greater ratio of lift to drift.⁷ The reduction in size of the rudder that is thus afforded, and its flat shape, when normal, greatly reduce the head resistance.

In so far as the action of a biplane is usually supposed to cause interference of the two surfaces, and greater head resistance, it would appear as if the biplane rudders as used on the Wright and the Curtiss were not as efficient as single planes. But the structural advantage of this arrangement is great.

The method used by Grade of only bending flexible surfaces, instead of turning fixed ones, has a great advantage in that the rudders after being used spring back to their normal position. This method has not been adopted on any other type, however, although it has many considerations of safety favoring it.

In almost all the aeroplanes that are flying successfully, excepting, possibly, the Wright and the Antoinette, the size of the rudders is generally conceded to be much too great. This is clearly upheld by the usual remarkably small change of inclination of the rudder that is necessary for a change of direction. This ultra-sensitiveness where, as in some machines, a movement of a few hundredths of an inch will considerably alter the state of equilibrium of the machine, is certainly undesirable. To begin with, it need hardly be pointed out that over-sensitiveness of a rudder invites dangerous situations. And, furthermore, if a rudder is extremely sensitive, then it is most likely too big, and if it is too big, then it is absorbing a lot of power that could be put to better use elsewhere. We may therefore look to a great decrease in the size of rudders as a development of the near future.

III. KEELS.

Keels on aeroplanes, like keels on a boat, add greatly to the stability. But on an aeroplane they are "dead surfaces," and as such have the disadvantage of offering greater expanse of surface for wind disturbance to act upon. Furthermore, they unquestionably deaden the motion and decrease the speed. Tapering keels such as used on the Antoinette, the Pelterie, and the latest Blériot XI, offer a maximum of "entering edge" with a minimum of area, and are for that reason more advantageous than rectangular shaped ones.

Keels are entirely absent in the Wright, Santos Dumont, and Cody.

In the Voisin type use is made of several vertical keels, partitions, placed not only at the rear, but also between the main surfaces themselves.

Keels add greatly to the resistance of a machine, the skin friction and consequent power absorption of such surfaces being considerable.⁸ It is generally conceded now, however, that control by rudders is becoming so perfected that any inherent stability to be attained by use of keels at the expense of power is hardly worth the while. No special form or combination of keels that have so far been designed and tried

have really succeeded in giving any kind of complete inherent stability.

Keels at the rear of a machine somewhat on the order of a bird's tail are nevertheless found advantageous, and we can expect to see such surfaces on aeroplanes for many years to come.

Actual practice shows that they do increase stability⁹ and tend to hold the machine to its course.

IV. TRANSVERSE CONTROL.

In practice the lateral stability of aeroplanes is preserved in four ways:

- A. Automatically.
- B. By warping of the main planes.
- C. By balancing planes ("wing tips," or "ailerons").
- D. By sliding panels ("equalizers").

The Voisin is the only type for which automatic lateral stability is claimed. The rear box cell and the vertical keels between the surfaces exert such a forcible "hold" on the air that to displace the machine is difficult and in all ordinary turmoils of the air it displays exceptional stability. A well-known aviator amusingly stated at Rheims that were a Voisin tipped completely over on one end it would still be aerodynamically supported, so great is the expanse of vertical surface.

Without such keels, however, the lateral balance of any aeroplane is so precarious that some form of control of warping the main planes for the preservation of lateral balance include in addition to the Wright all the present successful monoplane types except the Pitzner.

Because of the structural difficulty of rigidly bracing the surface of a monoplane, warping is an ideal

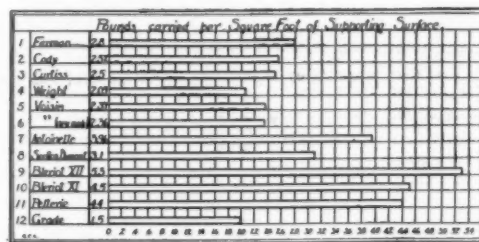


TABLE II. (a).

form of control. But the rigid structure of the biplane permits auxiliary planes (wing tips) to be more easily provided. This is done in the Farman, Cody, Curtiss, Sommer, and the recent Voisin.

These two methods of transverse control are both very efficacious, but the additional resistance, unaccompanied by any increase of lift, which is produced by balancing planes, perhaps renders them less desirable than warping.¹⁰ On the other hand, there are objections to weakening the structure of the main surface by making it movable.¹¹

There is a further distinction between these two methods of control which, although not thoroughly understood, appears to be borne out in practice, viz., when a plane is warped the action tends not only to tip the machine up on one side, but also due to the helical form assumed, there is a tendency to turn, which can only be counteracted by a vertical rudder. In the case of "wing tips," however, due to the equal but contrary position in which they are placed, both sides of the machine are equally retarded, and in addition, since the main surfaces preserve the same shape and the same angle of incidence, this tendency to turn appears to be absent. Mr. Curtiss states that for correction of tipping alone he makes no use whatever of the vertical rudder.¹²

Sliding panels as applied to the Pitzner monoplane represent one of the recently designed methods of transverse control which are thought to be no infringement on the patent rights of the Wright brothers. This system has not been adequately tried out as yet, but there is no reason why it should not be as effective as the system of warping or the use of wing tips.

There are many other methods designed to give transverse control, and it seems at present that they are all equally reliable. Structural individualities of the types of aeroplanes will in all likelihood persist and we cannot picture the machine of the future with any one kind of transverse controlling apparatus. Wing tips, ailerons, are widely used at present, but further progress in aerodynamics is likely to show us that warping is better.

* Accepted as thesis for the degree of A.M., Columbia University, June, 1910.

V. ASPECT RATIO.

It is at once observable from the values given that the ratio of spread to depth (aspect ratio) of the monoplanes is generally less than that of the biplanes. This interesting fact is due very likely to the structural difficulty of making the wing of a monoplane long and narrow, and at the same time retaining the necessary strength without undue weight. The Antoinette builders have very lately decreased the depth and increased the spread of this type of monoplane, thus increasing its aspect ratio, but the framework had to be greatly strengthened.

The Voisin (new model) has the highest aspect ratio of the present types, but exhibits no remarkable qualities therefrom.

Theoretically and experimentally the value of this quantity is considered to have much to do with the ratio of lift to drift; but whether or not in actual practice, those machines like the Santos Dumont having as low an aspect ratio as 3 to 1 are really inferior in their qualities of dynamic support to a machine like the Cody with as high an aspect ratio as 7 to 1, is difficult to determine, since many other quantities such as the loading and the velocity are involved. It is interesting to note here that some of the large soaring birds, notably the albatross, may be considered as aeroplanes of very high aspect ratio.

The effect of aspect ratio upon speed is not discernible on comparing the types.

Greater stability, however, is commonly supposed to be given by a high aspect ratio, because of the decreased proportionate movement of the center of pressure.

A further advantage to be derived from a high aspect ratio is that the higher the aspect ratio of a plane the lower is the angle giving the maximum ratio of lift to drift and consequently for given speed and loading less power is necessary.

There is little question that a development in aeroplane construction in the near future will be an increase of the aspect ratio to even as high, possibly, as 12 to 1.

VI. INCIDENT ANGLE.

The incident angle (i. e., the angle the main inclined surface makes with the horizontal line of flight) varies greatly in the different types. The Wright biplane is noticeable for its low angle of incidence in flight, which rarely exceeds two degrees.

Renard, after deductions from the experiments of Borda, as well as Langley and other investigators, has enunciated the principle that as the incident angle diminishes, the driving power expended in sustaining a given plane in the air also diminishes.¹³ Wilbur Wright states that "the angle of incidence is fixed by the area, weight, and speed alone. It varies directly as the weight, and inversely as the area and speed, although not in exact ratio."¹⁴ Faraud concludes that small angles are the most efficient for all aeroplanes.¹⁵ There is for each aeroplane a most efficient angle of incidence where the power expended for flight is least. In flight the incidence should be kept constant at this value in order to obtain the highest speed.¹⁶

The Farman, Voisin, Blériot XI, Grade, and Sommer have an angle of incidence when first starting much greater than when in flight. Since this involves greater drift resistance and consequently more power necessary to attain the velocity of levitation, and, furthermore, in view of the fact that aeroplanes with as heavy a loading but no excessive angle are able to rise after a reasonably short run, it would appear as if this provision were unnecessary.

Recent experiments in aerodynamics indicate that the ratio of lift to drift, with a surface of the shape now so generally used, varies little between the values of 2 degrees and 6 degrees, a maximum value being reached in the neighborhood of 3 degrees.¹⁷ This explains in a measure the wide variations in this angle as observed and recorded for the different types, and also that many of the present machines preserve their equilibrium during comparatively large changes of their longitudinal inclination.

In general the incident angle of the monoplanes is greater than that of the biplanes. The most common angle is in the neighborhood of 5 to 7 degrees. But in the Blériot XII, an incident angle of 12 or 13 degrees is often used in flight.

Incidence will very likely be established purely by the lift-drift ratio of a plane, and the incidence kept as constant as possible to give this its highest value.

VII. PROPELLERS.

Most of the aeroplanes are equipped with a single small high-speed screw.

The Wright and the Cody are the only machines provided with two propellers rotating in opposite directions. The greater efficiency of a propeller of large diameter and slow revolution over one of small diameter and high rotative speed¹⁸ has attracted much attention. This seems to be borne out especially in the case of the Wright machine, in which more thrust is obtained per unit of power than in any other type. The limit of rotative speed in practice is in the neighborhood of 1,500 r.p.m., and in all types excepting the

Wright, Cody, and Blériot XII, the r.p.m. exceeds 1,000. Many of the aeroplanes use Chauviere wooden screws, for which an efficiency of 80 per cent is claimed. The Antoinette, Voisin, and Grade use metal propellers.

The thrust and efficiency of the various propellers are about the same for equal sizes, and although the theory involving the propeller is very little understood, the experimental methods used have enabled the design of propellers of as good or better efficiency than those used in marine practice.

The position of the propellers at the front in most of the monoplanes is largely a matter of convenience of design. The swiftly moving mass of air from the propeller, however, exerts an added lift when thrown back on the plane. At the same time this action increases the resistance; but as the frame resistance of the monoplane is much less than that of the biplane, the propeller can be placed in front without very serious consequences. The Voisin (tractor type) has the

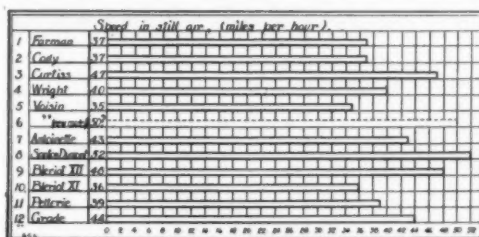


TABLE III. (a).

propeller at the front, but the results so far indicate that this is detrimental to the speed.

It is generally believed by aviators that much better results could be obtained by the use of propellers of 15 or 20 feet diameter rotating slowly. But there are two disadvantages involved in this feature of construction which make its adoption in the machines of the future rather doubtful. The first is the greatly added weight of so big a propeller and the second the difficulty of building a good chassis high enough to permit of the propeller's rotating freely.

VIII. EFFICIENCY.

One of the best indications of the general efficiency of an aeroplane is the amount of weight carried per unit of motive power. This quantity is usually termed the "pounds per horse-power," and is arrived at by dividing the total weight of the machine in flight by the horse-power of the motor. In Table I. (a)* the pounds per horse-power for each type previous to January, 1910, are given both numerically and graphically.

In Table I. (b) the same quantity is given in order of magnitude, using the most recent data.

The Blériot XI. (racing model) appears at present to be the most wasteful of power, while the Wright is by far the most efficient. It must be borne in mind, however, that the Blériot is much faster than the Wright. The Grade, Sommer, and Santos Dumont, appear also to be inefficient in this regard.

Table I. (b).

	Pounds per Horse-Power.		Pounds per Horse-Power.
Wright (1910 type)...	41.0	Curtiss	22.0
Wright (rear control)...	37.0	Farman (racing)...	21.0
Farman (passenger)...	34.0	Blériot XII. (1910)...	21.0
Blériot XI. bis (1910)...	29.0	Blériot XI. 2 bis...	19.8
Antoinette (1910)...	27.0	Voisin (racing)...	19.5
Pelterie	27.0	Voisin (tractor)...	19.0
Cody	25.0	Grade	17.0
Farman (1910)...	24.0	Sommer (1910)...	16.0
Pittner	24.0	Sommer (racing)...	15.0
Curtiss (passenger)...	22.6	Santos Dumont...	12.0
Voisin (1910)...	22.5	Blériot XI. (racing)...	7.5

The Antoinette and Blériot XI. bis rank high, as does also the Farman passenger machine.

There are no general distinctions, however, that can

of the Wright, has probably much to do with its power economy. Less pounds are lifted per horse-power by the faster machines, but their speed, in itself, is a factor of efficiency.

There is also no general distinction between the monoplanes and the biplanes as regards the weight per horse-power.

A more direct indication of the aerodynamic qualities of the aeroplanes is the lifting power of the planes. This quantity, termed the "pounds per square foot" or "loading," is arrived at by dividing the total weight by the area of the sustaining planes, and represents the number of pounds carried per square foot of the surface.

A machine carrying a very light loading, however, is not necessarily inefficient, since many quantities, such as the velocity, the height it is desired to attain, and other questions of design, enter into the determination of this loading.

On the other hand, a heavily loaded machine may be very inefficient, for we can conceive of an aeroplane so heavily loaded that it cannot rise without the expenditure of great power.

As regards speed, the loading can theoretically be taken as a direct indication of speed, because the heavier the loading, the greater is the speed necessary for support.

There are many surfaces, however, that appear to be more efficient than others, in that they can carry much more loading without decreasing to any great extent the ease with which the aeroplane can take to flight, and there is little doubt that under precisely the same conditions some surfaces can lift more than others.

The effect of heavy loading on the landing of the aeroplane is naturally to make the landing shock very great. In the case of the Blériot XII., which has the heaviest loading, it is necessary in order to avoid this shock, to keep the propeller running at full speed even when alighting. This condition is undesirable and requires a large area to land in.

The machine with heavy loading when in actual flight, however, is less likely to be affected by slight pulsations of the air, since it tends more to cut through them because of its small buoyancy.

A heavily loaded machine cannot soar or glide as well as a lightly loaded one, nor can it rise to as great a height. This is a distinct disadvantage, especially in view of the recent high flying and what it augurs for the future in the way of soaring with motor cut off for long stretches of time and at great elevations.

Another bad effect of heavy loading on an aeroplane is the difficulty it has of starting in a wind; and the ease with which lightly loaded aeroplanes take to flight in squally weather was especially noticed at the recent aviation meetings abroad.

Heavy loading, however, involves also the question of economy, since less material need be used, and the design can be made more compact.

Table II. (b).

	Pounds per Square Foot		Pounds per Square Foot
Blériot XI. (racing)	5.76	Voisin (1910).....	3.14
Blériot XII. (1910)...	5.30	Santos Dumont.....	3.10
Blériot XI. bis (1910)	4.50	Farman (racing)....	3.90
Pelterie	4.40	Farman (1910).....	2.80
Blériot XI. 2 bis...	3.68	Sommer (1910).....	2.76
Curtiss (passenger)...	3.64	Cody	2.57
Antoinette	3.33	Curtiss (1910).....	2.50
Voisin (racing).....	3.27	Wright (rear control)	2.50
Sommer (racing).....	3.25	Voisin (tractor).....	2.36
Pittner	3.20	Wright (1910).....	2.05
Farman (passenger)...	3.15	Grade	2.00

In Table II. (a) the loading for each type previous to January, 1910, is given both numerically and graphically. In Table II. (b) are given the most recent values of this quantity for the types.

The Grade and the Wright have the lightest load-

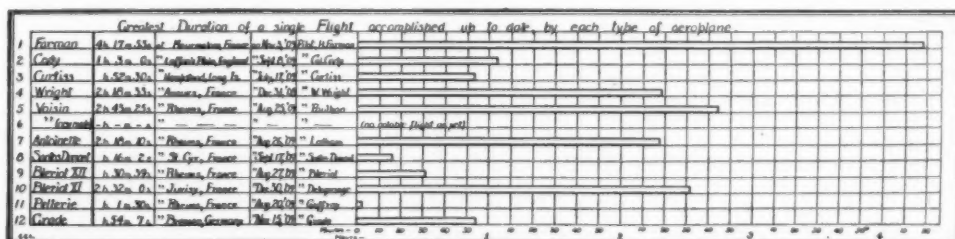


TABLE IV. (a).

be drawn. There is no special variation of this quantity with size, and it can only be pointed out that those machines using a high angle of incidence appear to be the most wasteful of power. The Wright has the lowest incidence, and utilizes its power best. But the use of two propellers instead of one in the case

* In these tables the Sommer and the Pittner are omitted because these aeroplanes are of very recent construction, and the tables were made before they had been completed (January, 1910).

ing, while the Blériot XI. (racer) has the heaviest. It is particularly noticeable that in general the monoplanes are more heavily loaded than the biplanes, the Grade being an exception. This, however, is not accompanied by any generally remarkable high-speed qualities of the monoplanes, as would be expected, but is probably due to the interference in lifting of the surfaces of a biplane with each other.

IX. SPEED.

The speeds of these aeroplane types, up to January,

1910, are shown graphically and numerically in Table III. (a). The recent values are given in Table III. (b). It can be seen at once that the speeds of the machines are all very much alike, the monoplanes not being in general any faster than the biplanes. The Blériot XI. (racer) is now the fastest, and the Cody the slowest. It is remarkable that the speeds of aeroplanes as designed at present seem to have a well-defined limit beyond which it is difficult to pass. M. Blériot in 1909 made 36 miles an hour on a monoplane driven by a 30 horse-power engine. Upon subsequently increasing the power to 50 horse-power he was barely able to reach a speed of 48 miles an hour, and upon increasing the power to 100 horse-power this year, he was, with the same type, able to make only 51 miles an hour. He then altered the design and finally was able to make over 60 miles an hour.

Table III. (b).

	Speed miles per hour		Speed miles per hour
Blériot XI. (racing type).....	63	Farman (racing type).....	44
Santos Dumont.....	55	Sommer (1910 type)....	44
Blériot XI. bis (1910 type).....	51	Wright (rear control). 43	
Antoinette (1910 type). 50		Wright (1910 type)....	41
Voisin (racing type)....	49	Farman (1910 type)....	41
Curtiss.....	48	Voisin (1910 type)....	40
Blériot XII. (1910 type) 48		Farman (passenger type).....	39
Blériot XI. 2 bis.....	48	Peltier.....	39
Sommer (racing type). 46		Cody.....	37
Pfützner.....	45		

The speed shows no direct variation with aspect ratio or loading, and higher speed appears to be attained mainly by an excess of power, a decrease of head resistance, and a small size of plane.

It seems doubtful at present whether we can, in an aeroplane, ever get up to a speed of 100 miles an hour. It is quite certain that to accomplish this the general type of aeroplane we now have will need considerable alteration.

X. FLIGHT.

In the manner of flight of the different types pronounced distinctions can be drawn.

Probably the widest variation in manner of flight exists between the Wright and the Voisin.

The flight of the Voisin machine can best be described as "sluggish." The enormous resistance of this machine seems almost visibly to hold it back, and in making turns the action is slow and "deadened."

In contrast to this is the strikingly birdlike flight of the Wright machine. The resistance of this aeroplane is very small, and consequently the machine darts easily through the air. When changing the direction in any sense or when correcting its stability, the action is precise and well nigh instantaneous. There is little question that the Wright biplane answers its helm better than any other type.

The Antoinette approaches the Wright in mania-bility, and the gracefulness of its form makes it also appear very birdlike. The Grade because of its light loading seems especially buoyant on the air, and the other types have characteristics intermediate between the extreme sluggishness of the Voisin and the remarkable preciseness of the Wright.

In Table IV. (a) the longest flight of each type up to January, 1910, is given both numerically and graphically. This table is at present only of historical interest, since, during the summer the records have changed considerably. The duration and distance record is now held by Olleslagers, who, on July 9th, 1910, flew 244 miles in 5 hours 3 minutes on his Blériot XI. 2 bis. From a purely aerodynamic standpoint an aeroplane should not be judged by duration of flight, because this depends much more on the skill of the operator, the endurance of the motor, and the amount of fuel carried.

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⁴ For description of this apparatus see *Aeronautics*, September, 1908.

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(To be continued.)

PHYSIOLOGICAL EFFECTS OF ALTITUDE.

A NEW FIELD FOR INVESTIGATION.

BY DR. CROUZON.

Even since the sixteenth century savants have been studying certain phenomena of altitude by means of ascent in balloons. Concomitantly marked physiological effects have been noted by the aeronauts, always troublesome and sometimes dangerous. Indeed, in 1875 the ascension of Sivel, Croci-Spinelli, and Tissandier terminated fatally.

Of recent years the Aero Club of France has conducted a series of physiological ascents whose results since 1901 we here summarize.

The Blood.—In its normal state the blood contains 5,000,000 red corpuscles per cubic millimeter. At great heights this number is much augmented. In other words, "hyperglobia" is produced. This is a constant phenomenon and frequently verified but difficult to explain. Gaule alone believes it due to the formation of new corpuscles. Other writers think it may be due to concentration of blood due to evaporation, but the most plausible explanation refers it to the unequal division of the red corpuscles by vasomotor phenomena dependent on many factors: cold, fatigue, intense light, activity of respiration.

Cold, particularly, can by sympathetic excitation, cause the contraction of peripheral vessels and thus augment the percentage of the red corpuscles in each drop of blood. It was therefore necessary to determine whether the deeper blood, that taken from the region of the heart, showed the same augmentation of red corpuscles. The experiments of Delille and Mayer proved that only peripheral blood was so affected. Analogous experiments were conducted by Crouzon and Soubies who made the interesting observation that a guinea pig kept warm and in a dry atmosphere did not suffer this effect, while it was manifest in guinea pigs kept in the open air or in a humid atmosphere.

The investigations of hemoglobine have led to the conclusion that the real percentage does not vary according to altitude, but that the apparent modifications are allied to the hypercorpuscular condition and due to vasomotor phenomena. The number of white corpuscles is not augmented.

The analysis of the gases of the blood gave the following results: Up to 3,500 meters the oxygen and carbon dioxide contained in the blood do not follow the law of the solution of gases. They vary in a direction inverse to the law. Nitrogen, however, follows the law of the solution of gases.

The quantity of oxygen and of carbon dioxide and the total quantity of gases in the blood augment with the altitude.

Arterial Pressure.—Hallion and Tissot found this invariable, whatever the altitude. Other writers get different results. It would seem that modifications of arterial pressure may depend upon other causes, and that altitude has no real effect.

Respiratory Changes.—These were studied by Hallion and Tissot. As the tension of oxygen diminishes the oxygen is more perfectly utilized and the coefficient of respiration remains the same. Likewise the amount of carbon dioxide exhaled remains invariable. But at a very high altitude the compensation is insufficient and asphyxiation commences.

Muscular force diminishes in very lofty altitudes and work rapidly produces fatigue. At still greater heights torpor renders work impossible and the least effort becomes painful.

Hearing is modified at high altitudes. At first, tympanic compensation is attained by the opening of the Eustachian tube, attended by the little clicking sound often noted in the act of swallowing. Later, auditory keenness diminishes and *paraconsia* augments, i. e., a development and increase of osseous audition occurs.

Visual keenness is somewhat augmented.

Sensitiveness seems diminished.

All these various effects produce a symptomatic complex known as balloon sickness, identical in character with mountain sickness.

It consists of difficult breathing, loss of appetite, nausea, and vomiting, loss of muscular energy, acceleration of pulse, venous congestion of face with hemorrhage of nose and lungs, diminution of urine, headache, and torpor, followed by the sleepiness and sensation of well-being which precede death.

Two theories are offered in explanation of balloon sickness: 1. The *anoxemia* of Bert, according to which the diminution of oxygen is the sole cause. He verified his theories by experiments with bells and therefore recommended the use of oxygen to the aeronauts of the ill-fated "Zenith." If torpor had not prevented their making use of it the fatal catastrophe might have been averted. 2. The theory of *acapsia*, i. e., an insufficiency of carbon dioxide in the blood. Agazotti recommended the breathing of a mixture of 13 per cent of carbon dioxide with 87 per cent of oxygen. According to recent experiments,

this is fallacious. It is found that pure oxygen is much superior.

To-day certain precautions unknown at the time of the "Zenith's" ascent are used in the breathing of oxygen. The use of an apparatus for expanding the oxygen permits the escape of a regular quantity of oxygen of 1, 2, 3, 5 liters per minute, and the wearing of a mask communicating with the expander by means of a tube relieves the aeronaut of the effort to raise the reviving gas to his lips. Thus torpor loses its perils.

These serious troubles are met with only at altitudes of four or five thousand meters or more. Hence they affect airmen in spherical balloons rather than other aeronauts, since neither dirigibles nor aeroplanes usually attain such heights.

Much remains to be studied in respect to these last. It is probable that their drivers may be unfavorably affected by their high rate of speed, by the noise of the motors, and the sudden changes of altitude due to rapid soaring and downward plunging. Cold and humidity would also tend to affect the aviator.

—Abstracted from *L'Aerophile* for the SCIENTIFIC AMERICAN.

A RADIUM FACTORY.

A RADIUM factory has been installed not long since at Islinge, in the island of Lindingo, Sweden, and it is now working very successfully. The radium is obtained by treating a mineral known as "kolm," which comes from the mines of Billingen. About sixty workmen are now engaged in taking out this ore. The radium works now employ some thirty workmen and treats about a ton of ore per day. It is expected to produce 4 or 5 grammes of radium salt in a pure state annually. An establishment at Paris known as the "Radium Bank" has made a contract with the Swedish works and will take the whole of its output. There has already been sent 5 centigrammes (0.75 grain) of radium bromide to Paris. The salt is shipped in tubes of platinum-iridium. It is found that the "kolm" ore is the best for extracting the salt. At first the works made a series of experiments upon ores of different kinds obtained from America and Australia, but these were found to contain a less amount of radioactive substances. The present price of radium is 400,000 francs per gramme (\$6,000 per grain).

AEROPLANES IN PARIS.—I.*

THE FRENCH SALON.

On examining the aeroplanes exhibited at the Paris show there seems to be some ground for the reproach frequently made that builders have not yet succeeded in establishing a scientific basis for the design of their machines. It is often argued that practical experience alone can provide the elements for the laying down of principles of scientific design, but it must be confessed that experience during the past year has not advanced knowledge of aerial flight to any considerable extent. As such experience has been acquired with very few types of machines it must necessarily be limited by the shortcomings of these mechanisms. Monoplanes and biplanes of what are now regarded as standard types have flown well, and have accomplished some wonderful performances in expert hands, but the numerous fatal accidents have convinced the public that there is a vast deal yet to be done before the aeroplane can become a practical machine. The driving of aeroplanes at higher speeds increases their stability while in actual flight, but it does not diminish the risks due to errors in manipulation, and particularly in stopping the rotary type of engine in order to glide to earth. Whether it is possible to obtain automatic stability may be open to question, although the models and designs shown at the exhibition for utilizing gyroscopic action prove that many inventors believe they have found a solution. Still, a certain amount of automatic stability is necessary, and this it is sought to obtain in the designs of two or three new biplanes. These designs appear to be the outcome of individual ideas, and not based upon scientific data, so that their value can only be demonstrated by actual flight. In the bicurve of Messrs. Sloan and Cle. the lower planes are joined at their extremities by the frame of an upper curved plane, which is not covered at the ends. It is claimed that lateral stability is obtained by "the compression of the mass of air between the planes," and that the upper plane acts as a parachute when gliding to earth. If the machine does all that is expected of it in the way of offering the maximum security, these claims will be worthy of serious investigation. The sustaining surface has 49 square meters, and the machine is driven by one or two tractor propellers, according to the requirements of customers. Another attempt to obtain stability by the form of the planes is seen in the biplane of Messrs. Turcat, Méry, and Rougier. In this machine the body, consisting simply of two pieces of large section wood, is carried in front between two vertical wood collars, which serve at the same time as a bed for the E. N. V. engine and support for the upper and lower planes. Both planes are curved from the center and deeply cambered. On each side of the two collars is a solid vertical strut connecting the upper and lower planes at their centers and extending below to the carriage and skid.

In both of the machines referred to, the designers have endeavored to strengthen the construction of the frames so as to render them entirely independent of piano wire for bracing. The several instances of aeroplanes collapsing have undoubtedly created a prejudice against wire and on many of the machines where this system of bracing is used, the main supporting planes have an additional attachment to the frame in the form of narrow steel strips. The trouble with piano wire is its liability to rust, whereby there is risk of its breaking after the machine has been in use

* The Engineer.

INKS AND FORGERY.

In Knowledge Mr. Alsworth Mitchell, who it will be remembered recently gave evidence in a case dealing with a forged will, has a striking article on inks. Incidentally he lets his readers into the secret as to the tests which he applies in order to discover the age of any particular piece of writing. If it is shown that the ink on a document purporting to be drawn up say, ten years ago, is really quite fresh, then there is every chance that the writing has been forged. An examination of the color of the ink may be helpful. Blue-black ink may be recognized as fresh up to the sixth day and in after years its age may be told when the blue provisional pigment has faded and left only the black. The blue coloring as time goes on is hardly acted upon by reagents, but for a year or two it is. In fact, writing done within that time will at once diffuse if treated with a fifty per cent solution of acetic acid, whereas when it is five or six years old, diffusion, if it takes place at all, is very slow and limited in extent.

A still more useful reagent is a saturated solution of oxalic acid which causes the pigment of relatively fresh writing to give an immediate smudge, but has

for some time in all kinds of weather. An entire suppression of wire for bracing purposes has also been effected by M. Fabre, of Marseilles, whose system of building up planes is distinctly ingenious. The front member is made of two thin strips connected by short diagonal pieces, forming a section of 4 inches to 6 inches square, according to the size of the machine. At each end the diagonals diminish in length until the two flat pieces join. The transversal width is uniform the entire length. To the under part of this member is fixed the end of ribs which taper outward. The ends are strongly clamped to the member by bolts and nuts. Each plane is built up with three of these members secured end on by thick chrome leather, in which tongues are cut so as to allow of its being turned back each side and strongly fastened to the members. This provides a flexible joint, and enables the end planes to give a little under heavy stresses. Despite the rigid construction of the members, the planes are flexible both longitudinally and transversally. The upper and lower planes are held by four deep and narrow vertical wood standards, offering apparently ample strength to withstand the work put upon them. These standards are clamped to the front members. There is no mortising or jointing in any part of the machine which has to withstand stresses. The method of attaching the fabric is peculiar, this being done by passing the edges over hooks on the ends of the ribs, so that when not in use the fabric can be detached and folded up over the front members. It is also pointed out that this facility for detaching the fabric allows of the superficial area of the sustaining surface being reduced or increased as desired, according to the weather and the speeds at which it is intended to travel. The Louis Paulhan machine is built by M. Fabre upon this system, and the combination of strength and flexibility thus obtained is claimed to result in increased security. M. Fabre has also constructed an aeroplane specially for naval uses. Being built up in sections in the way already described, it can be packed up in a small space and readily erected on board ship, when it is launched on three floats. The machine appears to have easily taken its flight from smooth water, but some skepticism may be permitted as regards its capabilities for launching in the air from even a moderate sea. Nevertheless, this, as well as other ideas which have been put into practical shape at the Paris exhibition, are interesting as showing the possibilities of further developments in the future.

A biplane which has been attracting a great deal of attention is that shown by M. Henry Coanda. The whole construction is original, wood being employed throughout for the body and planes. The form of the planes has been settled upon, as the result of dynamic experiments carried out on locomotives on the Nord Railway. From the round front edge there is a pronounced curve for about a third of the depth, and from this point to the rear the plane is nearly flat, with only a slight angle of attack. Under the curved surface are a number of short projecting ribs, thick where they round the front edge and tapering to the point where the curvature meets the flat surface. It is claimed that these ribs have the effect of keeping the stream lines under the planes parallel, and thus insuring lateral stability. The planes are built up with ribs, over which are riveted very thin layers of wood, and though this system of construction

has the appearance of offering great rigidity, there must, nevertheless, be a good deal of flexibility, since the rear part of the plane, which is thin, is warped by steel strips in the usual way. The front part of the plane is fixed rigidly to two vertical tubes extending from the landing frame, but the center of the plane is pivoted by a universal joint, so that the slight warping necessary for stability takes place over the whole length of the rear part of the plane. The lower plane is shorter than the upper one, and the curvature is the same. The tail is of tapered cruciform design, exactly similar in form to a paper dart, and to the broad ends of the tail are hinged small controlling planes. The most original feature of the Coanda machine, however, is the turbine or fan which is contained in a wooden cone carried at the front end of the body. This centrifugal fan is driven by a 50-horse-power Clerget engine, and drives through a column of air 50 centimeters in front and 1.50 meters diameter at the rear of the cone. Mr. Coanda claims that his "turbine," as he calls it, exerts a much greater tractive effort than the propeller. The total weight of the machine with engine is said to be 420 kilograms. This aeroplane is only of recent construction, and the experiments so far carried out with it seem to have been of a merely tentative character, but it is understood that arrangements have been made for subjecting the machine to further tests after the close of the show.

We do not propose to describe in detail the different aeroplanes exhibited, for apart from certain new machines which had been more or less hurriedly prepared for the exhibition there is a great similarity in design. Few makers seem to have persevered in their efforts to ascertain the best positions for the propellers. Some who have experimented with propellers of large diameter turning at from 400 to 600 revolutions per minute between the planes have come back to the rapidly revolving propeller keyed on the engine shaft in the axis of the aeroplane body. This latter arrangement was for a long while regarded as defective, and superior results from the point of view of the utilization of engine power have undoubtedly been obtained with large and slower propellers revolving in such a position that the column of air does not encounter any obstacle. Nevertheless, this entails a complication with chain transmission that makers have sought to avoid, and as all successful machines this year have had the propellers keyed directly on the engine shaft there is a general tendency to follow this example. Seeing that engines of 100 horse-power and more are being fitted to aeroplanes under these conditions, it may be assumed that the limit of power has almost been reached, and it is highly probable that the question of propeller position will have to be considered more seriously than has been the case up to the present. Moreover, manufacturers of propellers have not been idle. Machines are exhibited fitted with four and even six-blade propellers, the latter naturally having a very fine pitch, while one maker, M. Leperdussin, shows two four-bladed propellers on the same boss but revolving in opposite directions. On the other hand, some makers are showing propellers with almost the maximum pitch it is possible to give them. The question of propeller efficiency is obviously still laboring under the vagueness incidental to all early experimental work.

(To be continued.)

very little if any effect on writing six or eight years old.

The first occasion on which chemical evidence as to the age of an ink has been given in the law courts was in the recent forgery case referred to above, in which Colonel Pilcher was accused of forging his cousin's will.

This will was alleged to have been written in 1898; and assuming this to have been the case the ink should have only reacted very slowly with the different reagents; there should have been little or no diffusion with oxalic acid; and if any slight diffusion occurred this should only have been upon the surface of the letters.

The ink on the will, however, gave an immediate reaction with the different reagents, and diffused at once with oxalic acid, and the diffusion extended throughout the whole of the letters. There was thus no doubt as to the ink upon the will having been written within the last year or two, and certainly within the last six years.

Checks written by the deceased lady during the last thirteen years were also subjected simultaneously to the same tests, and it was found that the ink upon those written in 1903 gave only a faint diffusion with

oxalic acid in the heaviest writing, while no diffusion at all was obtained upon the checks written in 1901.

The correctness of the conclusions drawn from these results was borne out by the confession of the prisoner, who, in the middle of his trial, pleaded guilty to having uttered the will knowing it to be a forgery, though he denied all knowledge of how it came to be forged.

In the Philosophical Magazine, Mr. J. W. Waters writes instructively on the decay of polonium. The nature of the product of disintegration of polonium is a matter of considerable interest. If the product is a solid substance, it will accumulate in the course of time, and if it is radio-active its presence will be shown by the deviation of the curve of decay of radio-activity of the polonium from an exponential curve. During the past few months Waters has determined the rate of decay of a specimen of polonium which was about five years old, its activity being therefore about 1/1000 of the initial activity. The rate of decay was found to be normal, being nearly the same as that found by Mme. Curie for the initial rate.

SCIENCE NOTES.

In the course of some experiments on the bending of electric waves around a large sphere, Prof. J. W. Nicholson examined the extent of the origin of transition from brightness to shadow when a radial oscillator is placed close to the surface of a perfectly conducting sphere. Ordinary considerations suggest the existence of diffraction bands of alternate maximum and minimum intensity. At an early stage in the analysis it is found, however, that the shadow produced by the sphere is much too complete to admit of diffraction as an adequate explanation of the experimental results, except in the case of very small orientations, and this is fully confirmed by the further development of the analysis, which shows the absolute impossibility of accounting for these results by diffraction merely.

The phenomena observed on mixing liquid air with water have been studied by P. P. von Weimarn. It seems that when water is poured on to the surface of liquid air containing a large excess of oxygen, it does not solidify immediately, but at first assumes a semi-solid consistency. When liquid air is poured into water, the bluish drops in some cases fall to the bottom, and in others rise to the surface, and become surrounded by atmospheres of gaseous air and thin elastic scales of ice. The water finally solidifies to a turbid, porous system; so that ice, as well as any other substance, for example, barium sulphate, may be obtained as precipitates of varying form and degree of dispersion, according to the rapidity of condensation. Condensed gases are very suitable dispersive media for obtaining such suspensions.

In the University of California Publications in Zoology, Prof. G. F. McEwen contributes an article on the temperature and density of the waters of the Pacific, which is an account of the hydrographic work carried on by the Marine Biological Station of San Diego. Observations have been made of the temperature and density of the waters of the Pacific near the coast of Southern California. It was found that certain in-shore and shallow water regions had a temperature 2 or 3 deg. lower than the rest of the ocean, though there was no difference in the density. This is accounted for on Ekman's dynamical theory of oceanic circulation. The following table shows how the temperature decreases with increasing depth, at first rapidly and then more and more slowly; the density steadily increases with increase of depth. There were, however, several striking variations from this general rule.

Depth in Fathoms.	Temperature.	Density.
0	21.5 deg. C.	1.02486
75	11.0	1.02512
150	10.5	1.02525
250	9.7	1.02523
350	9.2	1.02531

H. Bierry, V. Henri, and A. Ranc publish in the Comptes Rendus experiments on the action of ultra-violet rays on certain sugars. Aqueous solutions of carefully purified *d*-fructose (identical with levulose), are placed in quartz vessels of 30 cubic centimeters capacity and exposed to the radiations of a mercury arc, at about 15 deg. or 65 deg. C. The 37 cubic centimeters of gas liberated in 24 hours at 15 deg. C. from 25 cubic centimeters of an 8 per cent solution, were essentially CO, further CO₂, and formaldehyde; the remaining solutions still contained some levulose, which was afterward entirely decomposed by fermentation. The gas liberation commenced after about 15 minutes. The higher temperature accelerated the

decomposition by the ultra-violet radiations. A ketose has thus completely been broken down into CO and formaldehyde simply by radiations, without the action of ferments or chemical agents—the first example of a complete degradation of this kind. In similar experiments with aldoses (sugar of the aldehyde type, glucose and others) only very little gas was liberated.

ENGINEERING NOTES.

During 1909 a good deal of extension work was done on the Japanese Government railways. The Kagoshima line (Yatsushiro-Kagoshima) was opened to traffic on November 20th. This completed the last link in the chain of railways from Hokkaido in the north to Kagoshima in the extreme south of Japan. Work was also carried on on (A) the Chuo (Central) line, (B) the San-In line (Fukuchiyama-Imaichi), (C) the Oita line, connecting Wusa and Oita in the north of Kiushiu, (D) the Toyama line, which will link up Toyama and Naoetsu, (E) the Uno line, running between Uno and Okayama, (F) the Ganyetsu line, connecting Niigata with the Nippon Railway at Koriyama, (G) various lines in the Hokkaido, (H) the Maizuru line from Sonobe to Ayabe, and (J) the Toba line, from Yamada to Toba. The suburban railways round Tokio were also electrified. Several important projects are also being considered by the Railway Board, such as the quadrupling of the Tokio-Yokohama line, the construction of a temporary ferry between Shimonoseki and Moji, the electrifying of the Usui section, and the construction of new and large central stations at Tokio and Yokohama.

A section of telegraph line, about 1,800 feet in length, was recently transferred from one to the other side of the railway which connects Natal with the Transvaal. In order to avoid interrupting communication, the new line was constructed while the old line remained in service. During the work, when the new wires, which were entirely insulated from the earth and from the service wires, were being put in place on the insulators, the linemen experienced many electric shocks, some of which were very severe. A series of experiments was made in order to determine the cause of these peculiar shocks. The wires were again insulated and connected with measuring apparatus. It is observed that electrostatic charges of very high potential were formed on the wires at the moment of the passage of trains, especially heavy trains, moving up the grade, which is 3.3 per cent at this part of the road; hence the experiments appear to prove that the wires were electrified by the friction of the moist steam contained in the smoke of the locomotive, which was driven against the wires by the wind. The effect was increased by the great dryness of the atmosphere in this region.

In the Metallurgical and Chemical Engineer, Mr. M. U. Schoop describes a method which he has devised for producing metallic coatings by a spray process. He discharges fused metal through a fine orifice and subdivides the jet by various means, for instance, by a current of vapor or gas (air, inert, oxidizing, or reducing gas) which meets the liquid jet at a right angle under high pressure; two liquid jets may also impinge upon one another, or other means be used. The fine particles of the metallic mist unite to a uniform adhesive coating, and as the particles cool down to 40 deg. or 60 deg. C. in rushing through the air under a pressure of 25 atmospheres, coatings may also be produced on paper, wood, and celluloid. The density of tin-coatings thus obtained was found to be 7.42, against

7.29 cast tin and 7.47 rolled tin; the hardness (Brinell test), of metals was much increased; the tinning did not crack off iron rods in tensile and torsion tests until fracture ensued; the experiments were made at the Zürich testing station. The process is recommended for producing adhesive coatings (mirrors, ornamental work) for metallizing balloon cloth, paper models, wooden propellers with aluminium, etc., and telephone poles, for making alloys, and for lining tanks; also for the manufacture of detachable deposits.

TRADE NOTES AND FORMULÆ.

Decoration of Hard Rubber with Colored Ornaments, Writing, Etc.—The rubber articles must be decorated with the color embellishments, bronzes, etc., while in a soft condition, and they must be burned in by subsequent vulcanization.

Hard Rubber Varnish.—Melt hard rubber, old comb, for instance, in small quantities in an iron pot, stirring constantly with a wooden spatula, so that the substance will not burn to the pot. As soon as it is all melted, pour the fluid mass on to a metal plate and after it has set, break it into fragments, which resemble shining black pitch. These are placed in a bottle and over them are poured 5 to 10 times the quantity of rectified oil of turpentine and the bottle left alone for several weeks in a warm place. In place of the simple turpentine, we can also employ a mixture of equal parts of oil of turpentine and benzole, whereby the solution will be effected in less time. The same must be decanted.

Gold Bronze Varnish.—For this purpose only a varnish free from acid can be used, otherwise the bronze with which the varnish is rubbed down will form a green verdigris. To free gum dammar from acid pour over 250 parts of finely reduced gum dammar, 1,000 parts of petroleum benzene, and by repeated shaking effect its solution. To this solution add 250 parts of a 10 per cent aqueous solution of caustic soda and shake them together vigorously for 10 minutes. After standing for a short time two strata will have formed, the upper petroleum benzene gum solution, the lower an aqueous one containing the resinous acids as salts of soda. Siphon or pour off the petroleum benzene stratum and shake again with 250 parts of the 10 per cent caustic soda solution. Allow it to stand until the separation and classification of the two fluids is complete, the dammar solution, siphoned off, will be absolutely free from acid. To prepare gold bronze varnish add to 1,000 parts of the non-acid dammar solution about 500 parts of bronze or bronzes (fine scaly metals).

Peroxide Hair Bleach (Auricome, Golden Hair Water).—A hair-bleaching medium, for imparting to dark hair a color between ash blond and golden yellow, is produced as follows: Nitrate of baryta is placed, in small quantities, in a highly heated crucible, and heated to an intense white heat. The caustic baryta thus obtained, is quickly rubbed down and preserved in bottles, hermetically sealed, as it rapidly absorbs moisture from the air. To obtain the barium-peroxide, necessary for the production of the peroxide of hydrogen, caustic baryta is heated to a dull red heat in a porcelain tube, dry air being at the same time blown over it. The peroxide of barium is dissolved in dilute hydrochloric acid (1 to 10) and to the solution, a solution of commercial caustic baryta is added, as long as a precipitate is formed, which is then filtered out and washed with distilled water. The moist precipitate is transferred to dilute sulphuric acid (1 to 10) until blue litmus paper is no longer colored red by the fluid and the colorless solution of peroxide of hydrogen obtained in this manner is filtered and preserved in a dark, cool place; under these conditions, it can be kept for two to three months without decomposing. The hair to be bleached is freed from grease by washing with soap solution, then washed with water and allowed to lie in the solution of peroxide of hydrogen until the desired degree of bleaching has been attained.—Bersch. Chemisch-technisches Lexikon.

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